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16. Abstract (Limit: 200 words)

This report contains information on national-level science policies, technology strategies, and research and development programs in West European science and technology in general and specifically in civil technology, with particular attention to transportation, energy, chemical manufacturing, industrial automation and technology transfer. The report will focus primarily on France and the Federal Republic of Germany, but will also cover important developments in Italy, the Netherlands, Sweden and other West European countries.

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SCIENCE AND TECHNOLOGY

No. 9

CONTENTS PAGE

CONTENTS (Continued) Page

FEDERAL REPUBLIC OF GERMANY

SHORT-TERM HEAT STORAGE IN 'COUPLED' HEAT/POWER SYSTEMS

Duesseldorf BRENNSTOFF-WAERME-KRAFT in German No 10, Oct 79 pp 397-402

[Article by F. Scholz, Juelich: "Hot-Water Storage Tanks in Long-Distance Heat Supply Systems With Power-Heat Coupling"]

[Text] By way of introduction we would like to recall that long-distance heat supply based on power-heat combination represents the best form of energy supply in the low-temperature home heating sector in terms of energy and in terms of the national economy. Short-term heat storage tanks in the form of huge, unpressurized steel tanks can be used at a small development expense and promise to contribute to the reduction of obstacles on the way to the increased utilization of power-heat coupling. In spite of the temperature limitation in the stored water to just about 100°C, the construction costs, related to the heat stored, are considerably lower than those connected with pressurized storage tanks used so far. Still, by taking over the heat supply function during electrical power output peak times, for example, they make it possible to use the electrical output from a tapping condensation block--which becomes available due to the introduction in heating-steam tapping--to meet the peak-time requirements. Other favorable utilization or operational cases are also discussed. On the other hand, long-term storage tanks are not given much of a chance.

General Remarks

Although this report deals mainly with hot-water storage problems, we will in the beginning make some general remarks on power-heat coupling and on long-distance heat supply because heat storage can represent a valuable aid for the accelerated expansion of this technology. There is hardly any other way with which it would be possible to reduce the home heating consumption--which is quantitatively highly significant--on a scale comparable to primary energy.

Power-Heat Coupling

By this we mean the uncoupling of low-energy heat during current generation in thermal power plants. In this process we get, as a result, a somewhat reduced electrical output from the power plant but we get a considerable useful output for heating purposes and a certain reduction in the heat loss. The main reason for the low "current loss" (ratio between electrical energy lost and electrical energy gained, which can be used as heat source) consists in the fact that one can use the entire condensation heat on a somewhat higher temperature level, for example, 120°C, for hot-water heating whereas that heat would have to be evacuated in case of pure current generation mainly as waste heat in the turbine condenser at about 35°C.

In the past, heat for heating purposes was drawn mainly from relatively small thermal power plants which were especially equipped for this purpose; now there is a gradual transition, due to the increase in the heat output, toward the use of big condensation steam power plants by tapping steam in the low-pressure turbine for suppling heat for heating purposes. The intention in the future is to use even big nuclear power plants (for example, PWR) for long-distance heat supply.

Figure 1 shows, according to (1), the circuit diagram of such a nuclear thermal power plant, consisting of reactor or steam generator, a double-suction high-pressure turbine, and two parallel-connected low-pressure turbines. The electrical output, without the tapping of heat for heating purposes, is 1,300 Mw. We have shown here a series of tapping operations for feed-water preheating and for hot-water heating. The hot-water system is characterized with t_V = lead-in temperature or t_R for the return. Provision is made here for 3-hour preheating, whereby the steam for the third stage is taken out of the overflow line running from the high-pressure to the low-pressure turbine. With this two-stage tapping procedure, we can attain lead-in temperatures of 120°C, something which is generally sufficient for long-distance heating purposes. The tapping profiles in the low-pressure turbine have been enlarged, compared to the standard version. Table 1 shows typical numerical values for such a thermal power plant without and with maximum two-stage heating-steam tapping.

If we forego only 50 Mw electrical output, we can thus make availabe 500 Mw useful heat output at a temperature level adequate for long-distance heat supply. In case of a heat pump, that would correspond to a quality index of 10 something which, considering the temperature level offered here, however would be impossible. With this heating-heat output amounting to a maximum of 500 Mw--which would be uncoupled over a long period of time throughout the year (6.5 months at full-load utilization)--one could supply just about 400,000 inhabitants almost throughout the year with heating heat and hot utility water. That would correspond to the home-heating supply of 40% of all inhabitants in a city of 1 million.

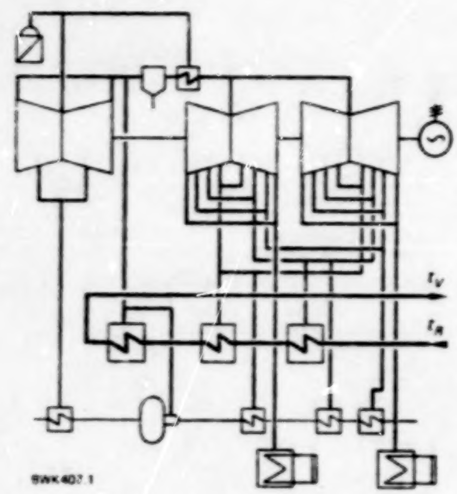


Figure 1. LWR-equipped standard nuclear power plant with enlarged tapping profiles for heat uncoupling.

Table 1. Power-Heat Coupling in Case of Heat Tapping by Means of Tapping Steam from a LWR-Type 1,300-Mw Nuclear Power Plant (Two-Stage Heating; Enlarged Tapping Profiles)

Thermal output		Electrical output		Heating-heat output		Waste heat output		Inhabitants supplied
Mw	%	Mw	%	Mw	%	Mw	%	
3,780	100	1,300	34	--	0	2,480	66	--
3,780	100	1,250	33	500	13	2,030	54	390,000

Of course, the reduced electrical output would have to be generated in another (nuclear) power plant. If we here again assume an efficiency of about 33%, then we would need a thermal output (primary energy utilization for substitute current procurement) of 150 Mw. If we compare this primary energy utilization to the heat output of 500 Mw which we get or, more appropriately, to the primary energy utilization of a fossil thermal power plant, which otherwise would generate heat with an efficiency of 88% and which would consume about 570 Mw of fossil fuel output, then we can see that we utilize the additional primary energy output from the power-heat coupling setup better by a factor of about 3.8. In other words, we save about 74% primary energy (specifically, expensive fossil energy which is in short supply).

If we were to use electrically-operated heat pumps in a decentralized fashion--for which we would assume an average output index of 3--then, in case of an electrical power plant efficiency of 33%, we would again precisely recover the primary energy utilization, required here, in the form of heat for heating purposes (although on a lower temperature level than in the case of the power-heat coupling arrangement). Compared to pure thermal power plant operation, there would be left over a primary energy saving corresponding to the thermal power plant efficiency (88%) of about 12%.

If we use as basis gas-driven or diesel-motor-driven heat pumps (constituting very high-grade fuels which are in short supply), with the same output index, then it is also once again true initially that they will precisely recover their primary energy utilization. It so happens that the mechanical efficiency of a motor that is not too big and that is not in uninterrupted operation is not above about 33%. But now would we also add about 45% of the primary energy which could be used for heating purposes and which otherwise would be released uselessly into the environment through cooling water or along with waste gas. Here, a primary energy utilization of 1.45 or savings of 31% would thus be possible. If we also consider the 12% heating plant losses, we would get primary energy savings of about 43% compared to the heating plant operation and, in spite of the use of high-grade, expensive, and scarce fuels, we would still be considerably below the figure of 74%, which was determined for the case of heat-power coupling, whereby in this case one can certainly use coal or nuclear fuel. The real primary energy utilization for the same heat output would be 26% in case of power-heat coupling; in case of a heat pump driven by a combustion motor it would be about 57%; in case of an electrically-operated heat pump, it would be 88%; and in a pure thermal plant it would be 100%, roughly on a ratio of 1:2.2:3.4:3.8. In other words, there is no known technology which can get along with a similar small and moreover longer-term available primary energy utilization in the quantitatively so large sector of home heat supply as can the power-heat coupling system.

These data therefore would lead us to expect very low costs for heat supply and point up the great potential for saving especially fossil primary energy. That of course under no circumstances means that the heat-power coupling system would also be the best solution in every case in terms of enterprise management.

Long-Distance Heat Supply System

In addition to the thermal power plant we use the following main components for a long-distance heat supply system: the long-distance pipeline from the HKW (thermal power plant) to the supply region (which applies especially when the HKW is a nuclear power plant or when it is a fossil-fuel led big power plant), a reserve and/or peak-load thermal power plant in or near the supply region, a far-flung distribution network and the transfer and home stations at the consumer's end. These plants and their operation determine the heat price at the home station. Additional costs spring from the home installation, the utility water heating unit, and finally the heating elements and the water turn over inside the house. Any cost optimization must consider all system components.

The full coverage of peak-time requirements by the HKW generally does not make any sense in economic terms because the systems in the HKW and the long-distance pipeline would then have to be designed for this peak load and would be needed at that output level for only a few hours throughout the year.

Figure 2 shows the properly arranged annual duration line within a supply region (1). Here we find plotted, above the utilization time, the particular heat output needed in percent of the peak output. The keying will tell us that, with a basic load share of 70%, we can already achieve 99-% annual heat supply from the HKW. In order to be able to meet also the very last percent of the annual requirement, the systems in the HKW and the long-distance pipeline would have to be designed for a heat output of 100% instead of 70%. In this case it would make sense to have an output share of 55%, corresponding to an annual heat requirement coverage rate of 97%. The required output exceeds the installed basic output by only 1,100 hr of the year. In other words, at the end of the long-distance pipeline, we must have a reserve or peak-load thermal plant with at least 45% of the peak output or an annual storage tank, the way some people have proposed. That storage tank could easily be charged during low-load times.

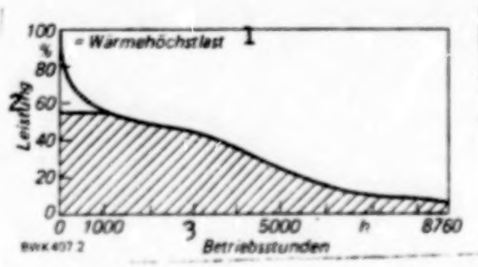


Figure 2. Annual duration line of long-distance supply, related to a minimum outside temperature of -12°C.
Key: 1--Maximum heat load; 2--Output; 3--Operating hours; h--hr.

4 Anteil der		Vollast-
1 Leistung	2 Arbeit	3 dauer
100%	100%	2825 h
70%	99%	3994 h
60%	98%	46[illegible]5 h
55%	97%	4890 h
50%	93%	5276 h
40%	82%	5728 h
30%	68%	6428 h

Key: 1--Output; 2--Work; 3--Full-load duration; 4--Share of; h--hr.

The makeup of the specific heating costs at various temperature spreads has been compiled in Figure 3 according to (2). We can see that the heating heat generation shares to the extent of only about 10-15%, the long-distance heat piping at a distance of 30 km between the thermal power plant and the consumer center to the extent of about 15%, the heat distribution with transfer and home stations to the extent of about 20% and, finally, the home facility, including the utility water heating unit and the heating element to the extent of the remaining roughly 50% out of the total cost of usable heating heat in the home.

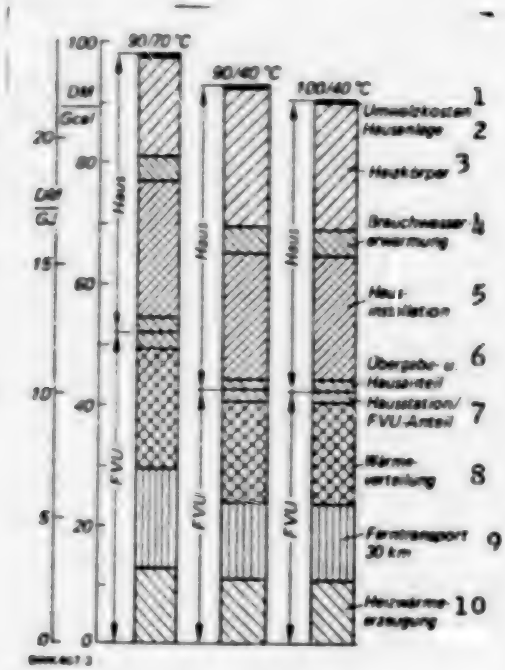


Figure 3. Makeup of specific heating costs in relation to selected temperature spreads for a supply connection output of 300 Mcal/hr (348 kJ/s). Key: 1--Circulation costs; 2--Home system; 3--Heating element; 4--Utility water heating; 5--Home system installation; 6--Transfer and home share; 7--Home station/share of FVU [long-distance supply enterprise; 8--Heat distribution; 9--Long-distance piping, 30 km; 10--Heating-heat generation; haus--home; FVU [long-distance supply enterprise].

Another problem consists in the fact that the heat requirement both throughout the day and especially throughout the year varies considerably. On top of that we have, as far as the power plant is concerned, the fluctuations in the electrical output requirements. An EVU (electric power supply enterprise) is legally obligated to supply electric outlets at any time. The simultaneous supply of heat complicates the plant's operation. Therefore, the interest on the part of the big EVU in power-heat coupling quite understandably is not very great. An EVU would like to be able fully to employ the available electrical power plant output at electrical power output requirement peak times instead of having to reduce that electric power output by having to supply heat, even if only to a minor degree. Now it so happens that, fortunately, the time gradients for heat requirement generally are not as high as in the case of current. Besides, heat is more easily stored and any possible shortage in meeting the requirements does not have as catastrophic an effect as a grid breakdown in the current supply. The entire long-distance heat transported is in one big storage tank and additional ones can be built if necessary.

Hot-Water Storage Tanks

Since water is a heat carrier anyway and a transport medium at the same time, it can also be used as a storage medium. It has a high specific temperature, it is cheap, and it facilitates high heat-transfer coefficients; it is non-toxic, it does not burn, and it is little corrosive. These advantages are countered by the chief disadvantage to the effect that water has a relatively high steam pressure. Storage at more than 100°C requires pressure tanks which are relatively expensive and which can hardly be built in big systems. But fortunately the heating costs drop along with the supply temperature likewise and 100° would be extensively sufficient for heating-heat and utility-water supply. The largest possible temperature difference between the lead-in and the return is a good thing or it is even required both for the storage tanks and for the long-distance heat supply system. A wide temperature spread in the tank, together with the specific heat and density of the water, gives us a great heat capacity per volume unit. To be sure, if a lead-temperature at a maximum of 100°C is given in advance, then the spread is confined to about 50 K due to a return temperature of 50°C (at most 40°C) which is considered realistic here. During times of high peak requirements, an increase in the lead-in temperature of the thermal power plant and/or reheating of the (storage) water, which has a temperature of 100°C, is possible in the peak-lead thermal plant.

Looking at it from the angle of the problem to be solved, we can distinguish between short-term and long-term storage tanks.

Short-Term Storage Tanks

They are used primarily to balance out the daily fluctuations in the heat requirements, to take care of the temporary uncoupling of current generation and heat supply and possibly to handle occasionally required larger heat volumes, for example, from peak-load current generation using the gas turbine or from other production processes, perhaps in the steel industry or the chemical industry. Figure 4 shows a time-load diagram for electricity and heating-heat requirements. A short-term hot-water storage unit could first of all handle the heating load peak. It would have to be charged during the night-time hours. During times of peak requirements of electric output one could furthermore reduce or entirely interrupt the heat uncoupling which would mean that the reduction in the electrical output caused by this steam tapping would be eliminated and this share would even be available for meeting the electrical peak-load requirement. Besides, with the help of the storage unit one could avoid, during the transition time, the operation of the thermal power plant which would be required only by the hour and that would additionally save expensive fossil primary energy.

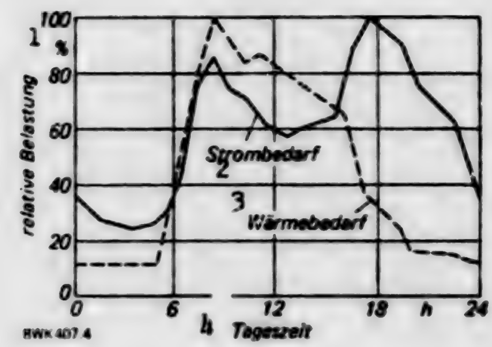


Figure 4. Relative load on power and thermal plant (Goldstern).
Key: 1--Relative load; 2--Current requirement; 3--Heat requirement; 4--Time of day; h--hr.

These utilization possibilities of short-term storage units thus invalidate a large part of the objections which the EVU still raises against the power-heat coupling system which is so urgently desired within the context of the national economy. The argument to the effect that peak-load current can be supplied in view of the possibility of quickly turning off of the steam tapping system as a matter of fact to some extent even turns these objections around completely. In (7), the storage facility costs permissible for this case were calculated at more than 700 DM/m^3; according to (5), they can be built for less than 100 DM/m^3.

Indeed, short-term storage units in power-heat coupling (of course, in relatively small grids) are already in use. To be sure, these storage tanks are in many cases made in the form of pressure tanks because of the high lead-in temperatures which had been customary so far; this means that they are very expensive and that their capacity is limited. More recent investigations have shown that the specific storage unit costs can be reduced considerably if one employs pressureless large cylindrical tanks similar to those customary in the mineral oil industry.

The technological problems in these storage tanks consists mainly of their size. For large storage tanks with a volume of 100,000 m^3, engineers have proposed diameters of 80 m and heights of 20 m. One main problem consists in the fact that one must build load-change systems which will permit the taking or simultaneous addition of heavily fluctuating hot or cold water currents. Here one must if possible avoid a turbulent mixture of hot and cold water and it is necessary to build up the thinnest possible stable and convection-free transition layer between the hot water and the cold water. When hot water is taken out, one must not fall below the steam pressure at the suction stud of the pump if one wishes to avoid cavitation; one must prevent the suctioning of air. Such storage tanks are built as layer storage tanks. Here we employ the--albeit small--density difference between hot water and cold water and, during charging, we add the warmer on top and we take a corresponding volume of cold water out at the bottom. During discharging [emptying], the direction of flow must be reversed. Refilling during load change into one or the other container would require an addition tank and thus additional costs (3, 4).

Figure 5 shows the specific system cost in DM/Gcal of storable heat volume according to (5) for different storage tank designs. We can see that, in case of a transition from a cylindrical pressure tank battery with 20 bar overpressure to a large cylindrical tank which is pressureless, it would seem possible to achieve a cost reduction, per stored heat unit, amounting to a factor of 5, although the usable storage tank spread would have to be reduced from 150 K to 40 K. The higher price for the stored heat at 200°C compared to 90°C is not considered here.

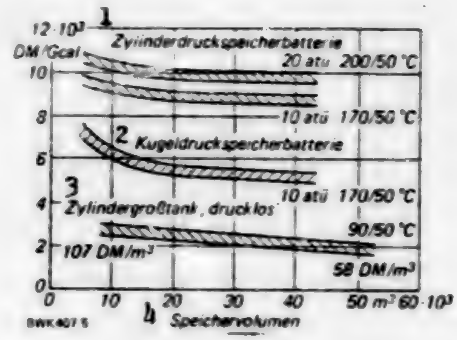


Figure 5. Specific system costs per Gcal of usable stored heat.
Key: 1--Cylindrical pressure-tank battery; 2--Spherical pressure-tank battery; 3--Large cylindrical tank, pressureless; 4--Storage tank volume; atu--ato.

Concerning the group of problems involved in load-change mechanisms and the layer system in the storage tank, we conducted load-change experiments together with the University of Essen on a cube-shaped storage tank (4.7 m x 4.3 m x 2 m high) which is available at the RWE [Rhine-Westphalian Electricity Works, Inc.], although at relatively low load-change speeds (3). We were able to determine that a stable and extensively predictable [computable] layering of the water can be achieved with relatively simple mechanisms. Figure 6 shows the vertical temperature curves measured.

Starting with a temperature of 30.5°C evenly distributed over the water level, we added about 0.6 m^3 hot water per hour at a temperature of about 69°C on top; the same water volume was taken out at the bottom. After 29 hours about half of the water level had been circulated and heated. The transition layer had a thickness of 60-80 cm, depending upon definition. The vertical temperature gradients in the beginning were satisfactorily large. Due to the unstationary heat pipeline they decreased already during charging [loading]. After this partial loading [charging], the very well insulated system (insulation layer consisting of polyurethane foam with a thickness of 0.5 m) was left to itself for 190 hours. Because of the previously mentioned unstaticnary heat pipeline, there was a further considerable temperature equalization during that time so that the possible tapping temperature on top, at the water level, for this reason and, not so much, on account of the heat losses toward the outside, dropped from about 67.5°C to 59.5°C. This tells us that this kind of partial charging, particularly in

combination with a subsequent idle time, has a very unfavorable effect on the recovery of the stored heat, especially if one needs that heat in order to meet the peak heat requirement in a far-flung long-distance heat supply network. One must therefore try to charge or discharge a hot-water tank rapidly and fully in order to use its volume if possible to the fullest extent and by exploiting the total temperature spread for heat storage.

It will therefore be a good idea to break up the required storage volume over several tanks. In this way we can better adjust, step by step, to the storage tank capacity requirement which fluctuates with the weather and the season; besides, we will be able extensively to avoid temperature losses due to the undesirable internal temperature equalization. Besides, the supply operation is rendered more reliable due to the subdivisions over several tanks. The temperature loss reduces not only the tank's capacity but also considerably decreases the value of the heat that can be taken out of the tank. If, for example, assuming that the return temperature is steady, we are to deliver the same heat volume to the consumer, then--as the lead-in temperature drops--the water volume will have to be increased accordingly. This means not only a cubically rising pump output requirement but the consumer at the same time would also only have a lower temperature level available. He would have to design his heating elements, his circulation system, etc., also for these lower lead-in temperatures--something which is very expensive. This is why the maintenance of the upper temperature level and thus of the full spread is so important precisely in a long-distance heat supply system.

This situation is also clearly expressed in Figure 7. It shows the share of the heat, stored in the experimental tank, at the end of partial loading, and at which temperature (curve with solid circles [dots]). We can thus see that, considering the experimental conditions described, especially after an idle time of about 190 hours, we were able to start using the heat only below 60°C. After taking out 50% of the stored heat, the utilization temperature had already dropped to about 53°C. Only at a temperature level of about 40°C were almost 80% of the heat, originally stored with water having a temperature of 69°C, available again.

In the upper curve on the other hand we assumed that we again discharged the storage tank immediately after partial charging. Heat losses and an "internal" temperature balance during the tapping time were overlooked. We realize, that in this case, with a tapping temperature of 60°C, we could already again have used about 75% of the stored heat; in other words, in the case involving a storage time of 190 hours (about 8 days), one could not take any heat at all out of the tank.

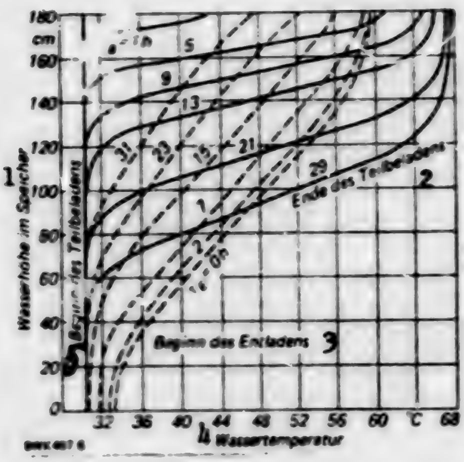


Figure 6. Vertical temperature distribution in storage tanks in case of loading--resting--unloading work cycle.
Key: 1--Water level in tank; 2--End of partial loading; 3--Start of unloading; 4--Water temperature; 5--Start of partial loading.

Figure 7. Share of recoverable energy in case of charging--resting--discharging work circle of model hot-water storage tank.
Key: 1--Energy utilization degree [efficiency]; 2--Tapping temperature; 3--Idle time 190 hours; Nutz--utilization; Sp--Storage; - ● - actually recoverable energy share during unloading [discharging]; - x - Maximum theoretical recoverable energy share at end of loading; - ■ - Maximum theoretical recoverable energy share at start of unloading.

To show that the assumptions connected with the theoretical determination of the discharging process do not lead to an impermissible misjudgment, the discharge process was computed in the same fashion also for the measured temperature curve after a resting time of 190 hours. As we can see, the difference between this computed curve and the measured one is not very big. This is due to the fact that the discharge time (at any rate, about 39 hours in the experiment down to the tapping temperature of 42°C) is short as compared to the resting time.

These factors play an important role above all in long-term storage tanks. In short-term storage tanks they would have to be considered if those tanks, for operational reasons, could not be fully charged or discharged over a period of several days. In that case the transition layer would grow and would have a correspondingly negative effect. This is why (see above) it might make sense to distribute the volume over several tanks in case of short-term storage, particularly when the storage time in some cases is several days or even weeks. The cost decline in the case of large tanks is not very great.

Annual Storage Tanks

In order to make the power-heat coupling even more attractive for EVU, it has been proposed to operate the thermal power plants, needed for heating-heat supply, in the summertime also if possible within the basic load range, to store the heat which is then no longer needed, and then use it in the winter to meet peak requirements. The engineers furthermore expected primary energy savings because better efficiency can be achieved during basic-load operations. But the heavy heat losses and their consequences were not correctly taken into consideration here. In dealing with annual [year-round] storage tanks however a considerable share of the annual heating-heat requirement would have to be stored. This is why, even in case of moderate network sizes, one would wind up with a storage volume of several million cubic meters. It was therefore proposed that one use or build natural or artificial lakes for this purpose (6).

Although these proposals might look attractive, their implementation does not prove to be as simple as all that and the attendant costs are unacceptable in terms of enterprise management. We investigated the problems as part of a team work with college institutes and an engineering outfit (4). One of the proposals investigated in this connection is illustrated in Figure 8. This is a single-lake storage facility with a floating cover. The artificial lake of $5 \cdot 10^6$ m^3 has a square surface of about 400 m on each side and a water depth of 40 m. A 0.2 m thick PU-foam insulating layer prevents major heat losses into the ground or to the underground water. In order to protect this layer against the penetration of moisture both from the tank and from ground water, it is surrounded on both sides by a layer of foil which is assumed to be water-tight. A protective concrete layer acts as buoyancy guard in order to prevent the insulating layer from floating up if the inside foil springs a leak and in order thus to avoid its destruction.

The water level is covered by a floating insulating layer which is likewise supposed to be protected against moisture from the basin water and against the penetration of precipitation water by means of foil. It turned out later that organic foils in combination with polyurethane-foam were not sufficient here. The water level rises with the charging state by a maximum of 0.7 m. Sloping foam layers were designed to divert precipitation water. About 2/3 of the stored water in this design are above the terrain level, something which is not exactly desirable in terms of the safety of the people living in the area--already if we think of the dam breaks in canals in recent times.

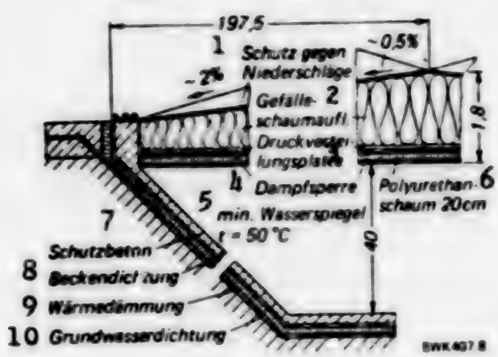


Figure 8. Storage lake with a volume of $5 \cdot 10^6$ m^3.
Key: 1--Protection against precipitation; 2--Sloping foam layer; 3--Pressure distribution plate; 4--Steam lock; 5--Minimum water level; 6--Polyurethane foam, 20 cm; 7--Protective concrete layer; 8--Basin seal; 9--Heat insulation; 10--Underground water seal.

Although a series of technological questions in connection with the water-pipe and, with increasing depth, pressure-impacted insulating lining of the basin, the insulating, water-tight cover, including the evacuation of precipitation, subsequently did not prove to have been resolved sufficiently, we did arrive at cost figures of DM25 to DM40 per m^3 for a tank with a size of $5 \cdot 10^6$ m^3, depending on the decision as to whether the storage facility is to broken up into several basins or whether it will get a floating or fixed cover. From the safety-engineering angle such hot-water storage lakes likewise are not entirely unobjectionable because a large portion of the water is placed above the environmental level. This is due to the fact that the earth excavation volume was used to pile up dams in order to keep the earthwork cost from rising to an unacceptable level. Great difficulties also spring from the question of the ground water level both during the construction and during the operation of the storage facility. An impairment of underground water and soil chemistry due to leakage and heating is likewise not to be ruled out entirely in spite of the precautions taken. Even if we consider all of these outlined problems as being soluble, the cost situation must be termed hopeless. The main reason is to be found in the fact that the storage volume actually can be used only once a year. According to our investigations, which coincide with other independent

estimates (7), the specific construction costs, including the charging and discharge pumps, etc., would definitely have to be below 10 DM/m^3. At that price tag, according to our considerations, one cannot build a hot-water lake no matter how willing one may be. Besides there are estimates which show that the energy requirements for the construction of annual storage tanks is greater than the heat volume which they would store in 30 years--not save, in other words (8). To be sure, these estimates for container storage facilities were made in connection with solar energy utilization; but here again one must ask this question when one thinks in terms of big annual storage facilities.

Table 2 shows some statistics on the cost situation.

Table 2. Costs Connected with Annual Heat Storage

Storage spread (usable)	40 K
Volume requirement for 1 Mwh	21.5 m^3/Mwh
Specific storage costs (estimate	45 DM/m^3
Storage tank construction costs per Mwh	970 DM/Mwh
Number of utilization operations	1 per year
Annual expenses (including operation and maintenance)	15%
Heat storage costs 145 DM/Mwh	
For comparison:	
Heating costs as of thermal power plant	appr. 8 to 12 DM/Mwh
From pure thermal plants	appr. 32 to 40 DM/Mwh
(in case of little utilization, rising to)	appr. 70 to 90 DM/Mwh
Costs of solar heat (without storage facilities)	appr. 150 to 250 DM/Mwh

To store 1 Mwh we need about 21.5 m^3 at a usable temperature spread of 40 K. If the storage tank costs "only" about 45 DM/m^3, that would give us specific construction costs of 970 DM/Mwh of storage capacity. Because the storage facility can be used only once a year, this would lead to 145 DM/Mwh of stored heat at 15% annual operating cost rates (including operation and maintenance). This is counterbalanced by the heat generation costs from a thermal power plant amounting to about 8-12 DM/Mwh and from a pure heating plant amounting to 32-40 DM/Mwh. Even peak-load heating plants, which are required to maintain a reserve, attain costs of only about 70-90 DM/Mwh in case of operating times of about 1,500-1,000 hours per year. Of that amount, about 60-70% are fixed costs, that is to say, the costs of paying off the plant.

Because of this situation, which is very unfavorable for annual storage facilities, the research and development work on the construction of an experimental storage lake at the nuclear research facility in Juelich was stopped at the end of 1976. But two follow-on projects are being continued in the FRG and an experimental model, with a storage volume of 30,000 m^3 will probably be built in Mannheim (see also Beipel, W., "Construction of the First Earth-Basin Heat Storage Facility in Mannheim," BWK [Fuel-Heat-Power], Vol 31, No 2, 1979, pp 56-61); this is being done although the

planning work continued in the meantime (partly building on our experiences) would point to even higher specific plant costs than we had estimated at the time. It is intended that the storage facility be used, after the conduct of experiments, later on, on an annual cycle, as short-term storage tanks. An experimental model is being planned according to our proposals at the time in Wolfsburg in cooperation with VW and an engineering firm. Here, two smaller basins of about 10,000 m^3, each, are to be investigated with different cover structures and linings and shorter load-change times.

In the meantime, the original "father" of the storage lake (Prof. G. Schoell, Stuttgart) seems to have abandoned this concept. Recently he has, in partial agreement with Swedish proposals, been suggesting a solar heating plant with a steel container as an annual storage tank (9). Of course, the cost figures are very optimistic. His specific costs, both for the individual components and for the entire system, are below the previously mentioned Swedish planning data (10) by a factor of 3-4. Of course, in the case of G. Schoell we are dealing with a much bigger facility (supplying 1,000 inhabitants in the case of G. Schoell as against 50 single-family homes in the case of C. A. Svensson) and details might be solved at lower costs. But that under no circumstances explains the cost differences. To be sure, at this time there does not seem to be any low-cost and technologically similarly mature solution for year-round, single-purpose heating-heat supply based on solar energy. In this kind of centralized full-scale supply from solar energy with the help of collectors, conditions are far more unfavorable than in the power-heat coupling setup because:

1. The heating costs are a multiple of the construction costs in case of power-heat coupling (today about 150-250 DM/Mwh for heat at a maximum of 70-80°C, compared to about 8-12 DM/Mwh for power-heat coupling);

2. About 75% of the annual heat requirement must be stored (in the case of power-heat coupling investigated only about 24%);

3. The temperature level, which in comparison to the power-heat coupling is mostly lower, is even less suited for central supply in a long-distance heat supply network.

In conclusion we must not fail to mention that, both domestically and internationally, one must admit that there is another type of storage facility which has some chance; it works with water, the so-called aquifer storage unit (propagated in West Germany by Messerschmitt-Boelkow-Blohm, Inc., Munich) as an annual storage unit (11). Here, a more or less separated volume is used for heat storage from a layer carrying natural underground water. The technological, chemical, and biological questions or repercusions here at least partly are even more multifaceted and less clear than in the case of the storage lake. The construction of an experimental version is being discussed on an international level within the context of the IEA in Paris.

Conclusion

Many of the understandable objections (especially from EVU) against the accelerated expansion of long-distance heat supply based on power-heat coupling can be disproved through the construction of big, pressureless short-term container storage facilities. The development expenditures of such storage units is less and their employment, according to preliminary estimates, also seems to make sense in terms of enterprise management. Although these hot-water storage units can also save expensive and scarce fossil primary energy, for example, by bridging short and thus highly uneconomical operating times in the peak-load heating plant, their indirect potential for primary energy savings would seem to be much greater in the quantitatively very interesting sector of home heat supply if they help eliminate obstacles on the way to the expansion of power-heat coupling. Here, the possibility of rapid supply of electrical peak-load output--by means of short-term storage units--due to the interruption of heating-steam tapping could be helpful or there would also be a possibility of utilizing waste heat connected with peak-load current generation perhaps with the help of gas turbines. The supply of low-temperature heat which would be more favorable, both in energy and national economy terms, than in the case of power-heat couplings, is also hardly conceivable if we consider the most modern technologies (such as the heat pump which is driven by a combustion motor), quite apart from pure waste heat utilization toward whose implementation large hot-water storage facilities could likewise make an important contribution.

On the other hand, annual storage units of course can be built, basically, and they could reduce the construction of thermal power plants and they could also lead to a certain additional savings of fossil primary energy (in peak-load thermal power plants). On the basis of the cost situation, we cannot expect their large-scale technical utilization in the power-heat coupling setup in longer-range terms. Its potential for primary energy savings would appear to be very small, if it exists at all.

BIBLIOGRAPHY

1. Zenker, P., "Heat Uncoupling from Nuclear Power Plants Using the Model of the Oberhausen/western Ruhr Plan Study," ENERGIE, technical-scientific lectures at the German Industrial Exhibit in Berlin, 1976, Colloquium Publishers, 1977, pp 348-364.

2. Korek, J., "Long-Distance Heat Transport and Distribution," ENERGIE (same as in item 1, above), pp 328-343.

3. Leyers, H. J., Scholz, F., Tholen, A., "Theoretical and Experimental Determination of Temperature Distribution in Layered Hot-Water Storage Tanks," VDI-BERICHTE [Reports of the Association of German Engineers], 288, pp 27-32, 1977.

4. Scholz, F., "Hot-Water Lakes as Long-Term Heat Storage Facilities," VDI-BERICHTE, 288, 1977, pp 15-26.

5. Federal Research and Technology Ministry: "Possibilities of Using New Energy Systems; 'Secondary Energy Systems' Program Study," Part V, FERNWAERME [Long-Distance Heat], Bonn, 1975, p 337; Weiss Printing and Publishing, Monschau-Imgenbroich.

6. Schoell, G., "Hot-Water Large-Scale Heat Storage Units," VDI-BERICHTE, 1974, 233, pp 33-35.

7. Gerken, A., "Boundary Cost Considerations on the Economical Utilization of Heat Storage Units in the Heat-Power Coupling Setup," VDI-Berichte, 1977, 288, pp 153-162.

8. Dietrich, G., "Solar Energy as a Contribution to the Energy Budget--Storage Problems," conference reports on the lecture and discussion meeting, February 1977, Solar Energy Study Group, Inc., ASE, Kruppstr. 5, Essen, pp 49-52.

9. Schoell, G., "Economical Utilization of Solar Energy," Academy for Solar and Storage Technology, Wolfschlugen, Public-Service Foundation, 1978, pp 1/31.

10. Strensson, D. A., Dimensioning of a Solar Heating Station. Lecture at the 1977 International Seminar Heat Transfer in Buildings in Dubrovnik-Yugoslavia. International Center for Heat and Mass Transfer, Belgrade.

11. Weissenbach, B., "Storage of Detectable Heat in Gravel Soil," VDI-Berichte, 288, 1977, pp 47-53.

5058
CSO:3102

POWER PLANT TO BURN NORTH SEA GAS ON SITE

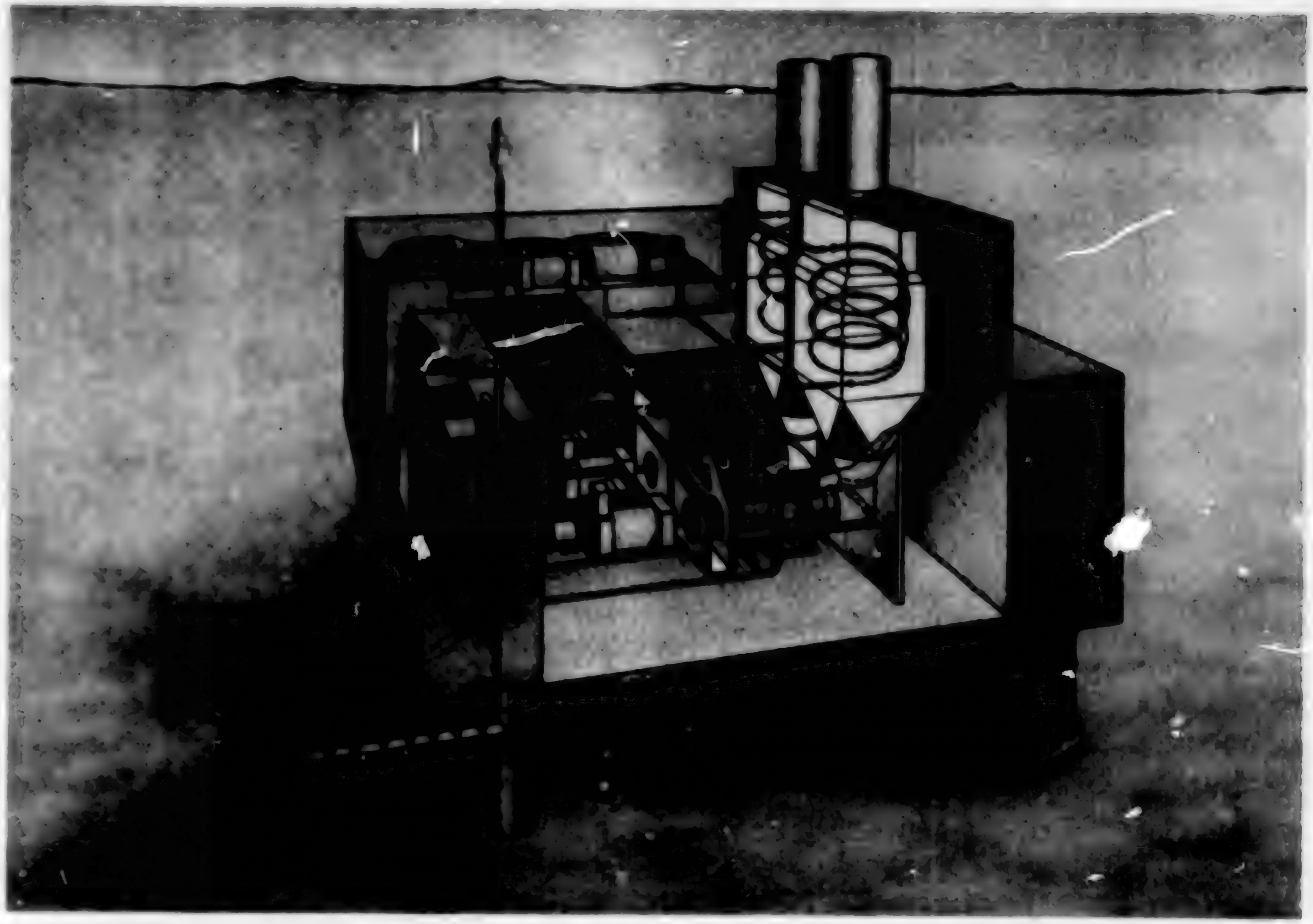
Duesseldorf BRENNSTOFF-WAERME-KRAFT in German No 10, Oct 79 p A4

[Text] An important component of the KWU [Power Plant Union] Development Program involves new energy technologies, for example, a natural gas power plant out on the sea.

In January 1979, the KWU received a purchase intention declaration from NWK (Northwest German Power Plants, Inc.) for the supply of two 126-Mw gas turbine sets and one 123-Mw steam turbine set. The turbines are intended for a power plant which is to be placed on a platform in the North Sea directly at the site of drilling operations in a natural gas field.

In order to use natural gas fields in the southern North Sea (100-400 km away from the German cost) for power generation, an offshore power plant is currently being developed under the project designation EPOS by Deutsche Babcock AG [Inc.] in cooperation with NWK and KWU. In this power plant, the waste gas heat from the two gas turbines is used in the manner of the KWU-GUD process in two waste-heat heat exchangers to generate steam for the steam turbine set. The power plant is being assembled in a shipyard on a floating platform with dimensions of 74 X 74 m and it will also be placed in operation there. Then the platform will be towed to the place of utilization (a natural gas field) and will be moved into operating position 20 m above the water surface.

The AC, produced by the generators of the three turbines, will be transformed into DC and will be transmitted to land by means of a high-voltage DC cable laid in the North Sea.



The EPOS power plant, equipped with two gas turbine sets and one steam turbine set, is to operate on a platform 20 m above the water surface. It will get its fuel directly from a natural gas field in the North Sea.

5058
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FEDERAL REPUBLIC OF GERMANY

PROSPECTS, PROBLEMS FOR PHARMACEUTICAL INDUSTRY

Frankfurt/Main FRANKFURTER RUNDSCHAU in German 17 Nov 79 p 13

[Article by Renate Miehe: "Heights and Depths in FRG Pharmaceutical Research -- Industry Feels Unjustly Criticized/ Return to High-Volume Mass-Produced Pharmaceuticals?/ Symposium of Contradictions]

[Text] Seven pharmaceutical companies located in Baden-Wuerttemberg recently sponsored a symposium in Heidelberg bearing this promising title: "Pharmaceuticals -- Value, Expectations, Economics." But since there was a shortage of critical pike in the fishpond, so to speak, the whole affair turned into a self-serving apology in defense of a branch which appears to count itself among the politically persecuted.

Thus it happened that Ministerial Director Albert Holler from the Bonn Ministry for Labor and Social Affairs came across as a lone revolutionary when he defended the government's anti-inflation measures. His gentle reference to the indeed quite healthy profits being earned by this branch of industry was intended as a reminder to the manufacturers that the threatened cutback on funds for research in the event of further "dirigistic" restrictions is by no means an urgent necessity.

Curt Engelhorn had already set the tone in his introductory remarks, saying that a defensive had to be launched against the wave of criticism which had been observable over the past 10 years. He said that those companies involved in research and particularly affected by economy measures were incurring service expenses in the sale of their new products "requiring explanation" that are much higher than those of companies offering inexpensive products. It was the view of Baden-Wuerttemberg Health Minister Annemarie Griesinger that the universal criticism of the pharmaceutical industry has to be viewed against the background of a general distrust of free enterprise, but also of a trend toward more natural methods of healing as well as an aversion to scientific progress, something which is widespread among progressives in particular.

Prof Ellen Weber, professor of pharmacology at the University of Heidelberg, surveyed the development and manufacture of a new pharmaceutical, which

today has to be made from 10,000 newly synthesized or isolated substances. The speaker called upon the manufacturers to subject to repeated strict quality controls not only their new products but also regular production. She said it was the task of pharmacology -- which is given little support in this country -- to educate the physician regarding the demands which a medication must satisfy.

Prof Wolfgang Schaumann, director of medical research for the Boehringer firm in Mannheim, painted a gloomy picture of the impending decline of pharmaceutical research in the FRG. According to Schaumann, price comparison lists, access to the market for low-cost producers and re-imports will, in the next 10 to 20 years, have the effect that new drugs will come only from abroad. He sought to refute the charge directed at the industry of inefficient duplication of research in many sectors by pointing out the historical expansion of research priorities in the case of individual companies; regardless, instances of covering the same ground were the result of honest competition. He said that to avoid duplication of effort would be to create monopolies in research and marketing. Unfortunately, there was no mention of the fact that quite a few critics of the pharmaceutical industry are more inclined toward the formation of monopolies and trusts than wasteful duplication. Prof Schaumann expressed regret that because of the law on cartels large companies could no longer "serve progress through joint research." It was his opinion that in view of the steadily lengthening periods of research, the present unfair and antiresearch patent protection for pharmaceuticals should not begin until the drug has been licensed.

It is unfortunate that the consequences of this proposal went unexplored. In the world of competition as it actually operates -- it would no longer be possible to check the competition via patent protection as early as the research phase of a product -- a flood of expensive, unproductive parallel research projects would be essential. Should the industry hope to come by the money for such parallel research by way of the longer term for patents? Or would it rely on pure chance that the research projects of competitors would not duplicate one another's efforts?

It is Prof Schaumann's opinion that tax measures and other forms of support could shore up private industry's research efforts; one possibility would be direct government aid for projects designed to treat rare diseases, or for pharmacological pioneer work with minimal chances of success. Following this invitation to the state to relieve the industry of its risks, unfortunately no one pointed out that the pharmaceutical industry in particular already enjoys substantial benefits from the basic research being conducted by universities or state-supported scientific societies.

Moreover, neither this lecture nor other presentations clearly stated what the pharmaceutical industry understands by research in general or just how large its outlays are for this item. There supposedly are companies which also group market research, quality control or customer information under this heading. Half of the firms invited to the symposium were subsidiaries

of foreign companies; one would indeed like to have heard something about the allocation of research responsibilities within consolidated corporations and about national research priorities. Another unfortunate omission was specific figures which could have offered proof of an actual emergency.

A defense of the small-step approach to research was offered, the search for follow-up products derived from precursor substances. Of course, this circumscription might be due not so much to the stiff competition as to the fact that true sensations in the natural sciences have in general become rare. Prof Schaumann described as "a partial expropriation" the opportunity for third parties to use research findings free of charge. Ministerial Director Holler remarked on this point that the introduction of royalty fees was certainly conveivable in Bonn.

"Waste of Health Services"

In his talk on the economics of pharmaceuticals in the health care field, Prof E. Kaufer (University of Innsbruck) criticized the excessive demand for therapy by patients who are overinsured and thus relieved of worries about payment; his criticism applied particularly to the realm of minor risks. He said that the law of the "Baumolsch growth disease" -- according to which the services sector in a healthy economy becomes expensive out of all proportion because otherwise manpower would migrate to industry -- was also at work in the health field. He noted that therapy involving charity or the use of apparatus would swallow up increasing amounts of money in the future, while pharmacological therapy would be the only area to make reduced costs possible (through economies imposed on the two costly sectors). He said that effective medications can make hospital stays unnecessary, reduce their length and take the place of operations. In all fairness, it probably ought to have been mentioned that operations can sometimes also make it unnecessary to swallow pills for years on end.

Prof Kaufer deplored government measures designed to eliminate the waste of health services resulting from overinsurance, to get away from the centralization of health insurance and to promote product competition in the pharmaceutical industry. He sees restrictions such as the transparent-overlay lists and price controls as a hindrance to the very kind of therapy which is the least expensive in the long run. The discussion should have expanded upon his opinion that since the introduction of national license restrictions the major portion of the money spent on research is no longer going for new discoveries. Long before the intervention of government control authorities, the number of true innovations had been dropping steadily all over the world.

Prof Kaufer accusingly brought up the example of a heart patient who was indeed able to undergo a costly and dangerous operation in the United States, but until recently it had not been possible to obviate this operation by ingesting a beta-blocker because the drug had not been approved by the pharmaceutical authorities. One could argue against this example by saying that

both doctor and patient appear to be more aware of the risks involved in operations than in drugs that are apparently being consumed with less hesitation.

It is Kaufer's contention that patients who are being protected from the risks of new drugs are being exposed to the dangers of older drugs and inappropriate therapies. It was presented as a probability that pharmaceutical companies would in the future have to concentrate their research on very profitable mass medications and low-cost short-term therapies with minimal risk of liability, although chronic diseases in particular have been increasing steadily.

In the none too controversial discussion -- one noted the absence of decisive comments from the health insurance authorities, for example -- Professor of Law Josef Isensee (University of Bonn) called for better educating the patient to the realization that service also costs something in the health field. It is Prof Isensee's opinion that reduced claims, within present capacity limits, and a curtailment of therapy rights offer alternatives to controls on the pharmaceutical industry.

Superficial treatment was given to the touchy issue of excessive consumption of medications by pensioners. It is Dr Georg Haerter's view that to the physician the price of the drug is last on the list of considerations, behind effectiveness and safety. He said that almost all patients go to a physician because they want to be treated with medicines, and that they would be dissatisfied if he prescribed only camomile tea and elastic bandages. Ministerial Director Holler called on physicians to point out to their patients other means of therapy in addition to drug therapy. Holler spoke out against the "particular imposition of group interests" and stressed that, for example, there is no law saying the maximum price for medicines is a fixed price. Kaufer pointed out that the "super price registry" of a transparent-overlay list, with its legally incomprehensible recommendations, helps not only the physician gain a better oversight but also the competing manufacturers.

Dr Winfried Felis, a chief hospital pharmacist, discussed the possibility of reducing health care rates through deliberate drug selection. He said, however, that there was no proof that potent drugs shorten hospital stays. He noted in addition that supply to hospitals of fresh and reasonably priced pharmaceuticals can and must be substantially improved.

The overall impression given by the symposium is that it is not the sick who are the poor swallowers of medicine, but the manufacturers. Nothing was said about the manufacture of the superfluous or the ineffective, nothing about greater innovation in other countries with less money spent on research, nothing about the small number of companies actually conducting research, nothing about the decline in research projects accompanied by rising sales figures. Declarations and demands alone cannot refute criticism.

7458
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FEDERAL REPUBLIC OF GERMANY

INDUSTRIALIST DISCUSSES FUTURE OF CHEMICAL INDUSTRY

Frankfurt/Main FRANKFURTER ALLGEMEINE in German 19 Nov 79 p 14

/Excerpt from article by Ko. datelined Vienna, 18 November: "Chemical Industry Must Step Up Research -- Seefelder: 1979 a Good Year for BASF"/

/Text/ The 1980's will be a decade of stiffer competition and radical technological change for the chemical industry, said Professor Matthias Seefelder, chairman of the board of the BASF AG /Baden Aniline and Soda Factory, Inc/, in a speech in Vienna. He noted, however, that future prospects for industrial chemistry would continue to be favorable. In the past, competition to substitute chemical products for other materials has been very successful. By contrast, the next few years should see increased competition by chemical products against one another, which would take in not only high-volume products but also more highly refined chemical sectors. Seefelder is convinced that in the future the German chemical industry will be made to feel more clearly than it has to date that many products can no longer be manufactured competitively in a high-cost country like the FRG. It therefore needs new technologies. It is for this reason that the already sizable outlay for research in the German chemical industry must be increased still further. Seefelder also referred to the substantial rise in demands pertaining to the environment and safety. It is his view that the "downright scaremongering" by segments of the public against the chemical industry -- which is increasingly perceived as causing problems rather than solving them -- will continue in the coming decade as well. Consequently, one of the chemical industry's most important tasks in the next 10 years will be to dismantle this crisis of confidence that exists in relation to the public.

7458
CSO: 3102

CRITICISM OF GOVERNMENT RESEARCH, DEVELOPMENT POLICIES CONTINUES

Complaints of Biochemical Researchers

Paris LE MONDE in French 6 Nov 79 p 6

[Text] The new government directives on scientific employment continue to arouse serious opposition within the various research agencies concerned.

The reactions are particularly lively in the biomedical research sectors, especially at the National Institute for Health and Medical Research [INSERM]: Now the unions are calling for a demonstration in front of the office of this organization on Tuesday 6 November, in the early afternoon, on the occasion of the meeting of the Administrative Council.

An open letter to the prime minister, entitled "To Safeguard Medical Research" which we published below, has been signed to date by more than 2,000 biochemical researchers*, including 195 university lecturers, hospital physicians, and 203 research directors and leaders, whose list is given below. They include 89 INSERM Unit Heads, 81 heads of hospital services, 13 heads of teaching research or univeristy units, 4 lecturers at the College de France and a Nobel prize winner.

This text repeats the main criticism leveled against the new governmental directives, which, we recall, provide in particular for a limit with regard to age for the recruitment of researchers (27 years, 30 for physicians) as well as a "forced mobility," according to the expression of the unions: The researchers finally recruited must necessarily be appointed in a laboratory other than the "receiving laboratory," in which they have tested their ability; and the promotion to higher posts (research masters and directors) will be subject to the requirement that the researchers should be working on a so-called "priority" subject.

According to the increasingly unanimous criticisms, these provisions incur, in particular the risk of destroying the cohesion of the best research teams, without, for the rest, helping to create new teams of high international level.

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* Persons desirous of joining this appeal may send their signature to Dr Asel Kahn, C.H.U. Cochin, 75674 Paris Cedex 14, or to Dr Gisele Guilbaud, 2, rue d'Alesia, 75014 Paris.

"Under Pain of Sterilizing Creativity"

This is the text of the letter addressed to the prime minister:

"It is with deep agitation that the scientific and medical world learned of the new governmental directives concerning the reorganization of the National Institute for Health and Medical Research [INSERM].

Indeed, the application of the measures contemplated would seriously jeopardize the working of all the research teams, while their standard is today acknowledged by the entire international scientific world.

The constitution and efficiency of a working group need patience and assiduity. It is therefore illusory to imagine that a coherent scientific production may be established on the principles of mobility established administratively. To compel the research groups to break up periodically is an absurd measure which would ruin all the efforts accomplished.

It is necessary for a nation to define a research policy: however, it should not sacrifice fundamental research and should leave ample room for the initiative of the scientific researcher for fear of sterilizing his creativity. To decide a priori the sectors in which research will be fruitful would have led to neglecting all the fields in which scientific progress has been outstanding in recent years. Many applications of research, now acclaimed, from "scanner" to "Genetic engineering," among many other examples, are based on fundamental researches, whose economic and social fallout could not have been foreseen by anybody. Sacrificing these studies would have caused stagnation, or even retrogression in the struggle for health. The attempt to "pilot" research taking into account only its immediate use is a short sighted policy leading to rapid stagnation in the acquisition of knowledge.

Meanwhile the arrangements concerning the age limit do not take into consideration the situation of a whole generation of young scientific researchers who have been waiting several years for admission into a research organization. The efforts and sacrifices of these young people, and those of the research training programs in which they learned their profession incur the risk of having been totally useless.

That is why the members of the scientific and medical community, who have signed this letter are launching a solemn appeal. The safeguarding of a high quality medical research, which has been established with great difficulty over a period of fifteen years depends on the suspension of the measures imposed on the National Institute for Health and Medical Research."

Response of CNRS Officials

Paris LE MONDE in French 6 Nov 79 p 6

[Text] During the debate of the National Assembly on the Research Budget, Mr Pierre Aigrain, secretary of state under the prime minister, in charge of research, had indicated, that the reform decided upon at the National Scientific Research Center [CNRS] had been established after consultation with all the section heads of the CNRS Committee. In the name of all the 41 section heads, seven of them, who constitute the permanent liaison group, sent us the following letter:

"The section heads have been received on two occasions by the ministers responsible for the CNRS: the first time in December 1976, by Mrs Saunier-Seite, minister for universities and Mr Aigrain; the second time by Mrs Saunier-Seite alone. During the first meeting, the discussion related only to the convenience of the simplification of administrative procedures and the use of laboratory funds: such measures would obviously not meet with the unanimous approval of the scientific community, which has been calling for them for several years. As for the second meeting, held on 5 April 1979 without the secretary of state for research, the section heads had prepared a text approved by more than three quarters of them and handed over to several ministers from whom the section heads requested interviews to inform them about their worries in the matter of the future of research. The text contained a number of concrete proposals aiming at a better adaptation of the structures of the research agencies to their objectives and at promoting a higher efficiency of the research effort. These proposals have not been discussed. A third meeting scheduled for 25 June was cancelled on the eve by Mrs Saunier-Seite.

The decrees published last September do not take into consideration in any way the proposals of the section heads: it is true that the description of the motives contain some positive elements, but the measures adopted unfortunately do not settle any of the problems now impeding the scientific development in our country and the application of the results to other social and economical sectors. They leave open many uncertainties as regards means, including the serious evaluation of the quantity of the research programs of the organizations. Furthermore, the stringent instructions which have just been given to the agency directors by the ministers in charge are all based on the Massenet Report. This text was established, without any consultation of the representatives of the authorities of the scientific community and without on-the-spot enquiry, by a person outside research circles and incompetent in the field of the difficult practical problems posed by the orientation and management of our scientific patrinomy; some of these recommendations incur the risk of causing serious lack of stability in our research teams with the highest performances. To speak of consultation in these conditions unfortunately reveals the lack of serious consideration shown by our ministers and their colleagues, who are gambling with the scientific future of our country.

9018
CSO: 3102

APPLICATION OF COMPUTER TECHNOLOGY TO POSTAL OPERATIONS

Paris AFP SCIENCES in French 11 Oct 79 pp 13-14

[Text] On 4 October in a Paris post office, Mr Norbert Segard, secretary of state for postal and telecommunications service, inaugurated the first financial terminal installed in the capital, which will allow for the extension of automatization in the administration of postal checks and the National Savings Bank.

This inauguration, accompanied by the presentation of a whole series of new materials, offers a preview of tomorrow's mail service in which, not only postal employees will make maximal use of facilities afforded by computer technology, but the public itself will have available to it many "self-service" devices that will, for example, permit people to weigh, figure out the proper postage for and stamp packages and to obtain various sorts of administrative (exam and competitive exam dates), financial (stock-exchange quotations), practical (like weather reports), postal rate information, etc., directly from the television screen through a computer consultation service that utilizes the ANTIOPE [expansion unknown] system.

The post office would thus become the public's computer technology antenna, enabling it to readily familiarize itself with this new technological revolution.

"But," Mr Segard emphasized, "the post office must not become a world of automation, rather a place where technical progress leads to reinforced social contact. Aided by computer technology, the postal employee will see his role as receiver and adviser expanded."

In more concrete terms, the minister specified that 10,000 CHEOPS [expansion unknown] financial network terminals, distributed througout the whole country, would be lined to 18 computer centers by means of 200 minicomputers. Installation will take from 5 to 6 years. Twelve post offices have already been provided with this equipment in the Nantes region. Equipping of the Paris post offices will be completed by the end of 1981 with 283 terminals distributed among 155 offices.

The overall operation represents a major investment on the order of 350 million 1979 francs. The contract for the job will be divided between the firm of LOGOBAX [expansion unknown] and the CGA-CII [expansion unknown] combine, the minister indicated.

Another service, the storing and reproduction of signatures on the screen will, in a few years time, make it possible to provide all postal check and Savings Bank operations, regardless of which post office the customer goes to.

As far as automatic stamping (for letters and packages) is concerned, the preproduction models will be tested during the second half of 1980 and the planned installation of 600 machines in 550 post offices will begin in 1981. Ten prototype "self-service" stamping machines will be tested under actual operating conditions in 1980. If the experiment is successful, the 200 biggest post offices in France could be equipped with them.

The first computer consultation service is to be initiated within the framework of multivalent administrative operations in association with the DATAR [Delegation for Territorial Development and Regional Action] and the Ministry of Industry in two predominantly rural departments, Lot et Garonne and Alpes de Haute Provence.

Mr Segard added that "the technological change now in progress can only be fully mastered with the active participation of all postal employees" and that is why, in the days to come, he plans to receive the labor unions to discuss matters with them, "to together discuss" the improvement of working conditions made possible by the technological evolutions now beginning or predicted.

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INDUSTRY MINISTER OUTLINES SOLAR ENERGY PROSPECTS

Paris AFP SCIENCES in French 18 Oct 79 p 7

[Text] Paris—"Solar energy, which we can expect to provide 5 percent of the energy France consumes, or the equivalent of about 15-17 million tons of oil, in the year 2000, will in any event make an important contribution toward meeting all of the nation's energy needs," said Minister of Industry Andre Giraud in response to a question from Member of Parliament Jacques Thyraud regarding the percentage of coverage of France's energy needs, published in the JOURNAL OFFICIEL [Federal Register] of 10 October.

The minister then provided the following details:

"In the housing sector, this objective means the installation of 5 million solar water heaters and over 2 million solar-heated housing units. As far as stabilization of the price of wood is concerned, the national effort planned would involve 25 million cubic meters, whereas the total consumption by industries and paper mills is today 40 million. Likewise, stabilization of agricultural waste would then require the processsing of over 20 million tons of straw or miscellaneous residual material. Thus the magnitude of the amounts at stake will enable us to better identify the role likely to be played by solar energy and the national interest it represents, but also the magnitude of the efforts to be expended to attain this objective and the physical or financial limits overly ambitious programs in this sector might very quickly reach. Moreover, international comparisons indicate that the French effort ranks a very respectable second in the world, ahead of Germany and Japan, as indicated in the following table which summarizes the solar energy budgets of the four chief countries active in this sector:

"United States:	2.45	billion francs,	11.10 per capita.
France:	211	million francs,	3.80 per capita.
FRG:	161	million francs,	2.50 per capita.
Japan:	76	million francs,	.70 per capita.

"The lead held by the United States can be explained as being due to a much bigger 'solar deposit' than ours, in terms of both the size of the country (15 times bigger than ours) and the much greater and, above all, much more regular amount of sunlight a good portion of the American countryside receives.

"In any event," concludes Mr Giraud, " the prospects of a solar energy contribution of 5 percent by the year 2000 represents a substantial step toward our country's independence in energy needs. In connection with this, we should remember that the nuclear energy contribution will not reach this figure before about 1981, or 40 years after the appearance of the first nuclear reactor. Solar energy will, however, be used in a much more decentralized and diversified manner than nuclear energy. The latter is mainly used to produce electricity, whereas solar energy will be applied more to produce heat energy, be it for heating buildings or providing heat for industry. It is likely that this new form of energy will be subjected to a number of different techniques, adapted to individual circumstances, and that we should not look to it to provide a unique solution to the problem of meeting our energy needs."

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LONG-TERM CHEMICAL STORAGE OF HEAT EXPLORED

Rome FONTI DI ENERGIA ALTERNATIVE in Italian No 1, Jan/Feb 79 pp 5-12

[Article by C. Vaccarino, of the Institute of Organic Chemistry, University of Messina: "Long-Term Heat Storage by Means of Hydratable Salts"]

[Text] 1. Foreword

Heat-storage systems that make it possible to use, as needed, the heat furnished by intermittent sources have already been proposed and applied for some time. In the specific case of solar energy, the systems used so far belong, as is known, to two main categories, which can be defined as the sensitive-heat type and the latent-heat type [1, 2].

The first category comprises systems using masses of substances with high specific heat per unit of volume (water, stone beds, metal heaps, etc) that are warmed by the solar heat absorbed through flat-type collectors. When the sun is not available, these masses cool and give up their stored heat, which can be used, for example, for heating a residential environment.

The second category includes systems using changes of state, and particularly the melting of solid substances (salts, eutectic mixtures, paraffin, etc): when the reverse change occurs through cooling, the fusion heat is recovered [3, 4, 5, 6]. We can place in this category also those systems that use salts hydrated with many molecules of water which, heated to a certain temperature, melt in their crystallization water but give up heat when, through cooling, they return to the hydrated solid state. Among the salts having this characteristic, one of the most studied for low-temperature heat storage is sodium sulfate, which, when the temperature falls below 32.4° C, crystallizes with 10 ml of water, developing about 58 kcal per kg of hydrated salt. Other salts proposed are: Na_2HPO_4 (which can furnish about 62 kcal per kg of hydrated salt), $Fe(NO_3)_2 \cdot 6H_2O$, $Na_2SO_3 \cdot 7H_2O$, etc.

In addition to various disadvantages of a practical kind that have impeded their diffusion (for example, the supersaturation phenomena that impede multiplication of cycles in the case of the hydrated salts [7]), all the storage systems referred to have a fundmental defect: that of deteriorating with time.

Indeed, even if the tanks in which the hot masses are contained are well-insulated, gradual cooling is inevitable. For this reason, and without reference to very large thermal masses such as subterranean lakes, which are capable of remaining hot for very long times [8], these systems are suitable only for short-term heat storage (a few days).

For truly rational use of solar energy, though, it would be important to be able to conserve it for many days, so as to avoid the necessity of using hybrid systems (which have, alongside the solar collectors, electric heating systems or systems using traditional-type fuel). The maximum objective would be seasonal heating, in which solar heat would be collected in summer for use in winter, something that would make the use of solar energy for heating extremely interesting even for the more northern countries, which have sunshine only for a short period of the year [9].

2. The Two-Component Systems

To achieve long-term storage of this kind, one must use systems that can be defined as two-component types. Generally speaking, such components are two products that can be conserved indefinitely at ambient temperature and which, mixed together, have the characteristic of combining, developing heat. The product obtained by their combination must in turn be able to be reseparated, by action of the energy that it is intended to store, into the two original components, which constitute the storage.

Systems of this type have been proposed that use the solution heat of certain substances, such as, for example, concentrated sulfuric acid, which, mixed with water, develops a considerable quantity of heat (about 76 kcal per kg of solution, when one passes from 100-percent H_2SO_4 to a 62 - 65% solution). By reheating the solution obtained in partial vacuum, the acid can be reconcentrated and the water vapor condensed apart, reconstituting the two components. Other substances that develop heat by dissolving in water are H_3PO_4, gaseous NH_3, etc; however, none of these systems has found practical application so far, for various reasons (regeneration temperatures too high, necessity of working under high vacuum or under pressure, corrosion problems, excessive volume of gaseous components to be stored, etc).

With the same type of two-component storage can be included systems that use chemical reactions: in this case, the solar heat causes an endothermic reaction, from which are obtained products that can be conserved at ambient temperature but which, put back together in the presence of catalysts, react by the inverse reaction, developing heat [10, 11, 12]. The intense studies being carried out in this sector are aimed at perfecting sufficiently simple cycles characterized by endothermic reactions requiring temperatures that are not too high (making it possible to use solar collectors that are not excessively sophisticated) and by exothermic reactions that prove to have good efficiencies at temperatures not much lower than the endothermic ones.

Finally, two-component systems can be considered to include those constituted by adsorbent solids, such as zeolites, silica gel, etc, capable of physically absorbing substances such as water, ammoniac, etc, with development of heat, and of restoring the adsorbed substances through subsequent reheating at higher temperature. Unfortunately, the heats obtainable in this way prove particularly high when the product to be absorbed is in the vapor state (in such a case, in fact, the condensation heat is added to the adsorption heat). However, it is obvious that use of a gas or vapor as the component to be conserved would lead to practically insoluble problems of volume. Another difficulty is that the quantity of product adsorbed, and thus the heat obtainable, are inversely proportionate to the temperature; therefore, these systems would prove suitable only for low thermic-level cases. Thus, according to a recent study, it would be possible to obtain hot air at a temperature of 30 - 35° C for area heating by sending humid air at 25 - 28° C over silica gel. The silica gel is then regenerated by by sending it through dry air at a temperature of about 56° C [13].

Apart from the limited applications of this type, the adsorbents cited could be used for summer conditioning plants by which it is desired to produce not heat but cold. In such case, their function would be to facilitate the evaporation of a refrigerating liquid, whose vapors are absorbed by them, while the heat developed is dispersed into the external environment (preferably at nighttime).

3. Description of the New System

In the present article is described a new two-component storage system especially well-suited to very long-term conservation of low- and medium-temperature heat, and the principal experimental results obtained are reported. These results, even if not yet definitive, have made it possible to clarify many aspects of the problem, and on the basis of them, it will be possible to launch a new experimental program designed to establish the effective possibilities of practical application.

The system is still based on the heat of formation of salts that crystallize with several molecules of water; but instead of starting from a hot solution from which the hydrated salt is separated by cooling, the process starts from a cold anhydrous or barely hydrated salt that is hydrated by addition of a calculated quantity of water. Regeneration of the hydrated salt is done by reheating in such a way that it gives up the crystallization water that is separated: this procedure reforms the two components which can be preserved indefinitely at ambient temperature, but which, mixed together, form the hydrated salt again, developing heat.

The heat Q necessary for regeneration of the hydrated salt can be considered as composed of three parts:

$$Q = Q_L + Q_B + Q_P \qquad (*)$$

Q_L is the heat of hydration of the salt, and corresponds to the portion of Q that is stored for a long term (which is restored by mixing water with the dehydrated salt again). Q_B is the heat necessary for raising the hydrated salt to temperature and eventually for removing the water, and can, as will be seen below, be recovered in large part as short-term heat. Finally, Q_p is the heat lost through thermal dispersions and other causes. It will therefore be possible, with a system of this kind, to speak of long-term storage efficiency:

$$\eta_L = \frac{Q_L}{Q}$$

and of total storage efficiency:

$$\eta_T = \frac{Q_L + Q_B}{Q}$$, in which heat Q_B, usable in the short term, is included also.

Table I lists some of the hydration reactions best-suited for achieving thermal storage of this type. The transition temperature (that is, the maximum temperature at which the most hydrated form can subsist in the presence of solution) and the hydration heat are given for each reaction. This heat has been calculated as the difference of the heats in solution in water of the two forms, with different degree of hydration, that correspond to each transition temperature.

For greater clarity, Figure 1 gives the solubility curves of several of the abovementioned salts, indicating the temperatures on the ordinates, and on the abscissas, the concentrations of the salts in solution. The individual points of the curves correspond to the transition temperatures referred to above, at which, for heating, one passes from a form with a higher degree of hydration to a form with a lower degree, with absorption of heat.

Table I does not include hydration reactions having transition temperatures lower than 30° C, this being the limit for use of heat for domestic purposes; in addition, an asterisk is used to mark those reactions with transition temperatures higher than 80° C--that is, those that would not be suitable for the present solar installations with flat collectors (but that could be used if collectors with moderate concentration, capable of going over 100° C with good efficiency, were available).

For the sake of simplicity, the reactions marked with an asterisk have been indicated in a single stage, but some of them actually include several hydration stages with decreasing temperature. Thus, for example, for bisodium orthophosphate Na_2HPO_4, which becomes anhydrous at 95° C, three crystallization forms, with 2, 7 and 12 molecules of water, are to be considered; the corresponding transition temperatures are 95°, 48° and 35°, and the hydration heats for them are 6.03, 10.91 and 11.53 kcal per mol. In the overall transition from anhydrous salt to dodecahydrate salt, 28.47 kcal/mol are developed, equal to about 200 kcal per kg of initial anhydrous salt, or 79.5 kcal per kg

TABLE I

Initial salt	Hydrated salt	Transition temperature in ° C	HYDRATION HEATS partial kcal/mol	total kcal/mol	total kcal per kg of hydrated salt
$Na_4P_2O_7$	→ $Na_4P_2O_7.10H_2O$	79.5		23.52	52.7
• Na_2HPO_4	→ $Na_2HPO_4.12H_2O$	95		28.47	79.5
$Na_2HPO_4.2H_2O$	→ $Na_2HPO_4.7H_2O$	48	10.91		
$Na_2HPO_4.7H_2O$	→ $Na_2HPO_4.12H_2O$	35	11.53	22.44	62.6
Na_2SO_4	→ $Na_2SO_4.10H_2O$	32.4		19.22	59.6
$Na_2CO_3.H_2O$	→ $Na_2CO_3.7H_2O$	35.7	13.00		
$Na_2CO_3.7H_2O$	→ $Na_2CO_3.10H_2O$	32	5.41	21.79	76.14
Na_2S	→ $Na_2S.9\,H_2O$	91		31.85	132.6
$Na_2S.5,5H_2O$	→ $Na_2S.9H_2O$	50		10.11	42.09
$CaCl_2.2H_2O$	→ $CaCl_2.4H_2O$	45.3		10.1	55.17
• $MgCl_2.2H_2O$	→ $MgCl_2.6H_2O$	116.6		17.4	85.7
• LiCl	→ $LiCl.H_2O$	93.6		4.21	69.6
$ZnSO_4.H_2O$	→ $ZnSO_4.6H_2O$	60(70)	10.8		
$ZnSO_4.6H_2O$	→ $ZnSO_4.7H_2O$	38(39)	3.5	14.3	49.7
• $Al_2(SO_4)_3.6H_2O$	→ $Al_2(SO_4)_3.18H_2O$	100		49.5	74.2
$KAl(SO_4)_2.3H_2O$	→ $KAl(SO_4)_2.12H_2O$	60		46.9	98.8

of dodecahydrate salt. If, however, one stays within a maximum temperature limit of 80° C, only the hydrations from 2 to 7 and from 7 to 12 molecules of water, which can furnish total heat of 22.44 kcal/mol, equal to 62.6 kcal per kg of salt at the maximum degree of hydration (as the table show also), are to be taken into consideration.

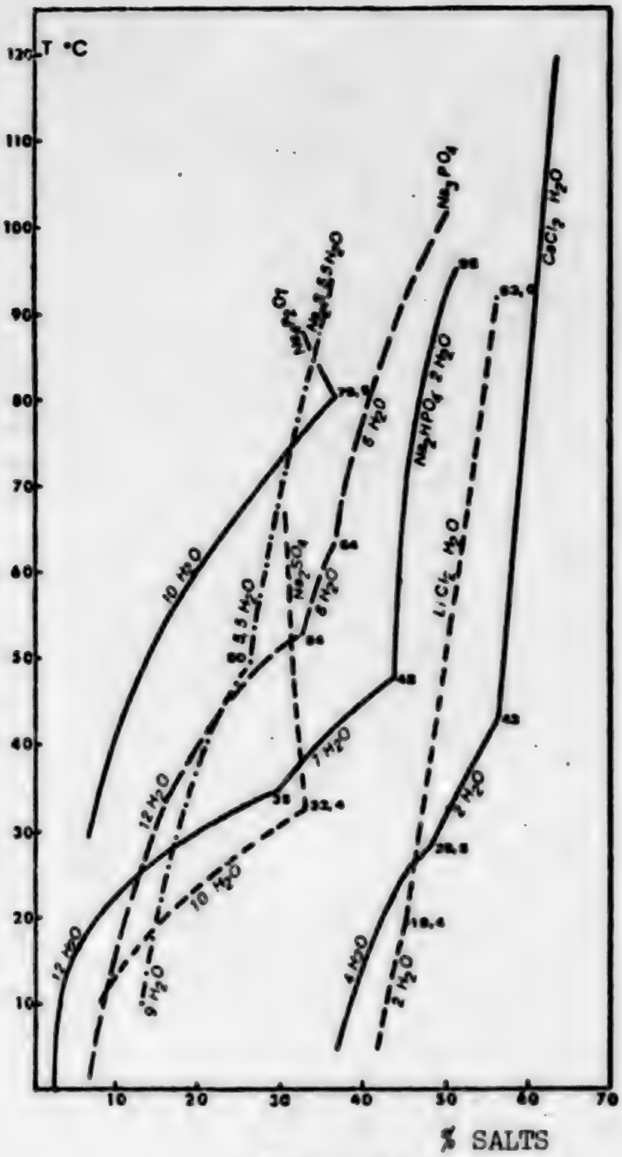

Figure 1.

Sodium sulfide behaves in a similar way; with a maximum temperature of 91°, it can theoretically furnish 132.6 kcal per kg of hydrated salt, and this quantity drops to 42.09 if the temperature has to be kept below 80° C. Hexahydrate aluminum sulfate, bihydrate magnesium chloride and lithium chloride, which do not have intermediate hydration degrees between 80° and 30° C, can be used only for storage at higher temperature.

If it is desired to establish a comparison between the theoretical heat-storage capacities obtainable with the system described and the short-term storage capacities already known, the data in the last column of Table I (excluding the reactions marked with an asterisk) can be compared with those in Table II. In the latter are calculated--always for the interval 80° - 30° C--the quantities of heat ideally obtainable with several of the most common sensitive-heat and latent-heat systems.

TABLE II

Heat Storable between 30° and 80° C

A. Sensitive-Heat Systems		
Water	50	kcal/kg
Stone beds	10.5	"
B. Latent-Heat Systems		
Paraffin wax	69	"
Eutectic mixture $Mg(NO_3)_2 \cdot 6H_2O$-$Al(NO_3)_3 \cdot 9H_2O$	57	"
acetamide-stearic acid mixture	72	"
urea-ammonium nitrate mixture	63	"
$Na_2SO_4 \cdot 10H_2O$ (hydration)	96	"
$Na_2HPO_2 \cdot 12H_2O$ (hydration) approx.	95	"

For the sensitive-heat systems, the following formula was used:

$$Q = c_s\ (*) - 30)$$

in which c_s is the specific heat of the storage material. For the latent-heat systems:

$$Q = c'_s\ (80 - t_f) + Q_f + c''_s\ (t_f - 30)$$

in which:

c'_s = mean specific heat of liquid (or solution)
c''_s = mean specific heat of solid
t_f = temperature of state transition
Q_f = heat of state transition (kcal/kg)

One sees that the densities of the heat stored for a long term by means of the new system are of the same order of magnitude as those of the already known short-term systems, and in some cases, distinctly higher. The advantage would be still greater if one considered hydrations at temperatures above 80° C.

It is also worth the trouble to point out that if one succeeded in eliminating irreversibly also the last molecules of the crystallization water of several

salts that require especially high temperatures, it would be possible to count on hydration heats, and therefore on theoretical heat-storage densities of very great interest, as emerges from the following examples:

	kcal per kg of hydrated salt	kcal per kg of anhydrous salt
$KAl(SO_4)_2 \cdot 12H_2O$	123.5	227.1
$MgCl_2 \cdot 6H_2O$	161.8	345.4
$Al_2(SO_4)_3 \cdot 18H_2O$	178.8	348.7

4. Experimental Results and Discussion

One of the first data inferred from the experimental tests is the importance, for purposes of repeatability of the cycles, of the system whereby the water contained in the hydrated salt is eliminated. Up to this point, in fact, we have spoken only about heating the salt to the point that it rises above the upper transition temperature, and therefore separates the water, which is thus freed. It is obvious, however, that separation pure and simple of the water (for example, by filtering it through the dehydrated mass) is ruled out, since a large quantity of dissolved salt would be removed with it, and this salt, in cooling, would then separate and be subtracted from the storage mass.

A process that has given good results, though, is to separate the water by evaporation. In this case, the heat Q_B which appears in equation (*) contains, in addition to the warming heat necessary for raising the hydrated salt to temperature, also the heat of evaporation of the water, which is greater than Q_L. This heat can be recovered by condensing the water in a heat-exchanger, and it will therefore always be possible to have an optimum value of η_T, while the value of $\eta_L = \frac{Q_L}{Q}$ would always prove considerably lower, since the heat to be used in the short term would always be preponderant over the long-term heat.

Such a circumstance, though, in the more general case of utilization of solar heat during the winter period, does not prove to be a negative one. In fact, the short-term stored heat can be used in those daylight hours in which the sun does not furnish sufficient heat and also during the nighttime hours, while the long-term heat can be used after a few days of total absence of sunshine. The situation is less desirable, though, if it is desired to store heat mainly for long terms, or even season-long periods. For such applications, as will be said below, it will be necessary to experiment with water-separation systems other than the evaporation system.

With this point clarified, we go on to the results of the experimental tests carried out with dehydration by evaporation. The salts used in these tests can be subdivided into three categories: (a) salts having high water-vapor

tensions but low transition temperatures; (b) salts having medium water-vapor tensions but high transition temperatures; (c) salts having very low vapor tensions.

Because of their low transition temperatures, the salts of the first category tend, with heating at atmospheric pressure, to melt partially or totally in their crystallization water. This fact, though apparently not a disturbing one (since such water could be evaporated in subsequent heating), turned out in several cases to be a great disadvantage, because the dehydrated salts remaining after evaporation proved incapable of being rehydrated. Salts behaving in this way were $Na_2SO_4 \cdot 10H_2O$, with a transition temperature of 32.4° C; $Na_2HPO_4 \cdot 12H_2O$ (first transition temperature: 35° C); and $CaCl_2 \cdot 6H_2O$ (first transition temperature, 29.8° C; second, 45.3° C).

This disadvantage did not occur with hydrated salts of type (b) having high transition temperatures, such as, for example, decahydrate sodium pyrophosphate $Na_4P_2O_7 \cdot 10H_2O$, which has a single transition temperature at 79.5° C. This salt yielded, by gradual heating in an oven and without any separation of liquid water, a dehydrated product which, once cooled, proved capable of easily reabsorbing the water, retransforming itself into a decahydrate salt and developing the concomitant heat. Behaving in a similar way are borax $Na_2B_4O_7 \cdot 10H_2O$, which passes to the pentahydrate form at about 56° C; $Na_2HPO_4 \cdot 2H_2O$, which dehydrates completely around 95° C; and other salts.

The cuase of this different behavior seems due to the fact that by evaporation of the solution formed by heating the salts of type (a), anhydrous or barely hydrated salts are separated that have an extremely compact structure and which absorb water only partially, if at all, and in very long times. In the case of the hydrated salts of type (b), though, in which the crystallization water is gradually liberated directly into the vapor state (before reaching the transition temperature), the final dehydrated product has a completely different nature, being voluminous and permeable to water--characteristics that are maintained even after the cycle is repeated several times.

In order to clarify better the reasons for the abovementioned phenomenon, the dehydrated salts obtained by means of the two systems are presently the subject of a special crystallographic study, the results of which will be published later.

A confirmation of the hypothesis that the lack of hydratability of the salts of the first type is connected directly with the presence of liquid water in the course of their dehydration was obtained in a series of experimental tests in which the formation of such water was avoided. The simplest system for achieving this objective is to make use of the phenomenon of efflorescence, shown by several salts having a particularly high water-vapor tension. One of these is decahydrate sodium sulfate, which, left in a thin layer in the ambient air for 24 hours, changes almost entirely into anhydrate by direct passage of its crystallization water into the vapor state. Although the dehydrated salt thus obtained has a composition similar to that of the salt insolubilized by the

saturated solution above 32.4° C, it proved capable of very readily reabsorbing the lost water, developing heat.

Obviously, dehydration by efflorescence at ambient temperature is not a system usable in practice, both on account of the long time required and because not all salts present this phenomenon. It has been seen, however, that it is possible to obtain the same result by heating the hydrated salt in a partial vacuum or in a current of hot air. The anhydrous sodium sulfate and bihydrate bisodium phosphate obtained with such systems have in fact shown that they too are hydratable and permit repeatability of the cycle.

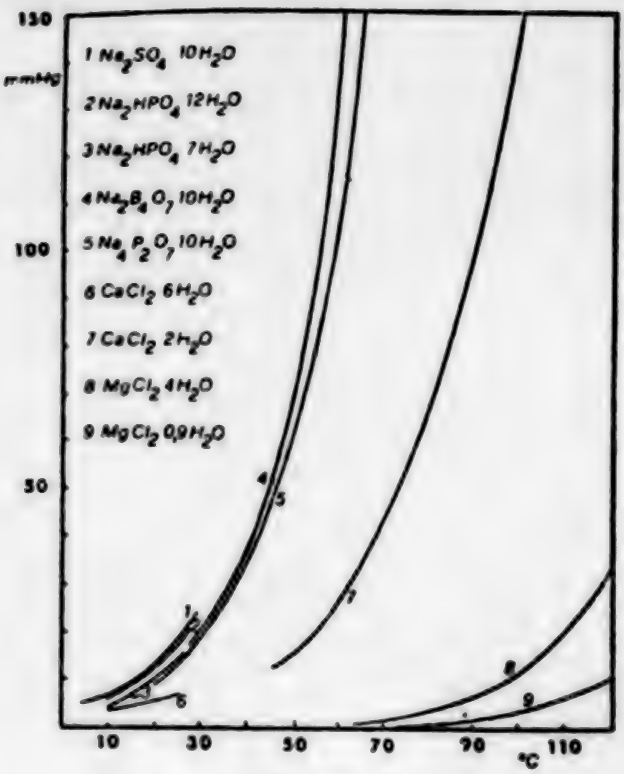

Figure 2

An important advantage of heating in the absence of water lies also in the fact that it would theoretically be possible in this way to achieve high degrees of dehydration at relatively moderate temperatures. In fact, while in the presence of the saturated solution, in the interval between two successive transition temperatures a salt maintains strictly the degree of hydration corresponding to that interval, in the absence of dehydration liquid dehydration occurs in a continuous manner and depends exclusively on the balance between the vapor tension of the salt and the partial pressure of the water in the atmosphere.

The concepts stated above are demonstrated in Figure 2, which gives the vapor tension-temperature curves for several of the hydrated salts considered so

far, drawn on the basis of data taken from the literature [14, 15, 16]. One sees, for example, that $Na_2SO_4 \cdot 10H_2O$ has, below its transition temperature (32.4° C), a vapor tension on the order of 20-10 mmHg. Since the partial pressure of the water vapor in the ambient air generally has lower values, it is explained how this salt can wither almost completely even at 15° - 20° C. $Na_2HPO_4 \cdot 12H_2O$ has a vapor-tension curve only a little lower, and it transforms by efflorescence into the heptahydrate salt, always at temperatures lower than the transition temperature (about 35° C).

Contrary to what happens with the two salts stated, the curves for borax and for sodium pyrophosphate show that it is possible to reach very high vapor-tension values by heating, while remaining below the respective transition temperatures (56° - 60° C and 79.5° C). The curve for $CaCl_2 \cdot 6H_2O$ shows that this product has, at ambient temperature, quite a low vapor tension (which is the reason for its deliquescence, the phenomenon opposite to efflorescence): it follows from this that if the transition temperature has to be kept below 45.3° C, it can be dehydrated only by working in a high vacuum or in a current of dry air. Only after the composition of $CaCl_2 \cdot 2H_2O$ is reached can the temperature be increased.

Figure 3

Even worse is the situation with $MgCl_2 \cdot 4H_2O$, whose vapor tension, even at 60° - 80° C, is so low that it must be considered impossible to achieve any

noticeable dehydration, either under vacuum or in a current of air. In order to use such a salt, therefore, it seems necessary in any case to get above, as has been said, the temperature of 100° C; and this has been confirmed by several experimental tests.

Figure 3 (in which the temperatures are indicated on the ordinates and the times on the abscissas) shows a typical course of the hydration process using sodium pyrophosphate, which is one of the salts that up to this time have been studied most, because of the simplicity of its behavior (only one high-temperature transition point). The numerous tests done have generally used quantities of anhydrous salt on the order of 100 grams, saturated with the theoretical quantity of water (or a little less than the theoretical quantity), to produce decahydrate salt, using a metal container insulated on the outside with glass wool. From the diagram it is seen that hydration occurs almost completely in the very first minutes and then continues more slowly, becoming nearly complete within about 15 minutes. The temperature increase recorded was on the order of 45° - 50° C, which is a little less than the theoretical increase, but acceptable when one takes into account the heat leakage due to the working conditions.

The hydrations done on other dehydrated salts had entirely similar progressions. It is an interesting fact that in many cases in which more water than the theoretical quantity was used for hydration, it was seen that the product obtained after the subsequent dehydration proved less capable of reabsorbing water. This phenomenon is further confirmation of the negative action of the presence of water in the liquid state in the course of dehydration, as was mentioned above.

Figure 4 gives, by way of example, a diagram of a heat-storage system of the type described (with hot-air dehydration), working in connection with a solar-energy domestic heating installation.

The hydratable salt, in many layers of small thickness, is loaded into the shelf column A, while the tank B contains the second component--water. When it is desired to use the stored heat, the pump P_1 is started, so that a quantity of water is mixed with the salt in A, hydrating it and developing heat. This heat is used to warm the air that circulates in A, flowing over the salt, and the air is moved by the low-head compressor P_2. The hot and humid air then gives up its heat in the coils s_1 and s_2 placed between the two water tanks C_1 and C_2. These tanks, maintained at the temperatures of about 50° C and 30° C respectively, constitute two short-term heat lungs that can be used, for example, to furnish hot water for domestic uses and warm air for winter heating, using appropriate systems whose design is indicated schematically by s_3 and s_4. The water that condenses in coils s_1 and s_2 returns to tank B, while the cold air is picked up by P_2 and continues to circulate.

When hydration of the salt in A is complete, the temperature of the air that continues to circulate begins to drop; and when it drops below 50° C, thermostat T_1 controlling three-way valve V_1 intervenes and sends the air through

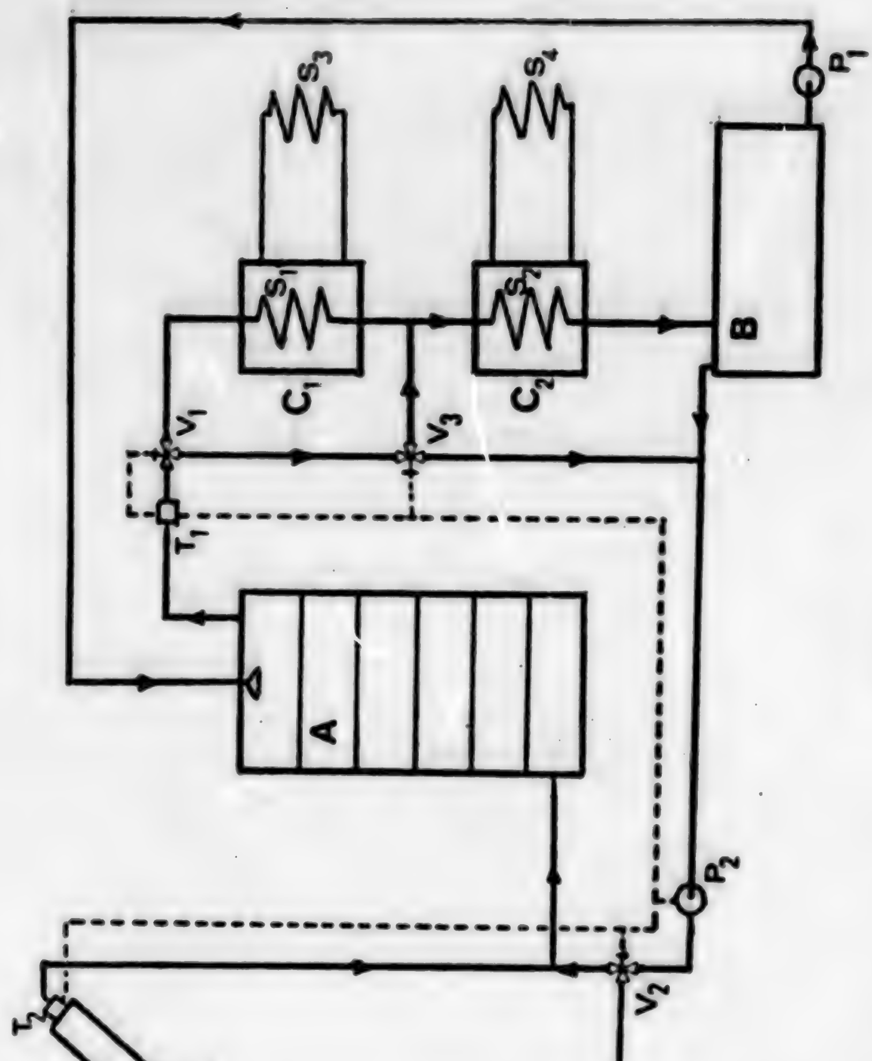

Figure 4

C_2 instead of C_1. When the temperature falls below 30° C, compressor P_2 stops.

To regenerate the hydrated salt, solar collector D is used, which can be of the air type or of the water type (in the latter case, the hot water heats the air). When the temperature at the collector head reaches a certain value, thermostat T_2 intervenes, activating three-way valve V_2 and compressor P_2 so as to make the air circulate first through collector D and then into column A, where it transmits its heat to the hydrated salt. This air exits from the upper part of A with an initially low but gradually increasing temperature; and in accordance with the temperature, and by means of the thermostatically controlled valves V_1 and V_3, it is sent: (a) again to collector D, if t is less than 30° C; (b) to coil s_2 if t falls between 30° C and 50° C; (c) to coil s_1 if t is higher than 50° C. Inside column A, the conditions are maintained for water to be liberated by vaporizing immediately, in accordance with what was said in the preceding pages; and the vapor produced, drawn along by the air, is condensed in the two coils s_1 and s_2. With circulation of the hot air continuing, all the salt contained in A is dehydrated, while the condensed water is collected in tank B; with this, long-term heat storage is reconstituted.

The system can nevertheless continue to function until the solar collector is is capable of warming the air, whose heat goes to the short-term lungs C_1 and C_2. When there is no sun and the air temperature drops below 30° C, thermostat T_2, acting on V_2, cuts D out of the circuit and stops compressor P_2. From this point, it is possible to use, for heat needs, the heat from short-term storage C_1 and C_2, until they run out.

A variant of the above scheme consists in direct use, for heating residential environments, of the air at about 30° C obtained after condensation of the water in S_2. In such case, part of this air can be sent to the thermoconvectors, with its humidity possibly adjusted beforehand, while the ambient air will replace it in the cycle. Naturally, integration of water in B must also be provided for.

5. Work to Be Done

It is planned to build a small experimental installation expressly designed for repeating the hydration-dehydration cycle very many times, working in different conditions and making all the necessary measurements in a systematic manner.

One of the essential aims of this small installation will be to try out new dehydration systems that do not involve doing evaporation of water. This will be in order to have more long-term than short-term heat storage. One of these systems that has already been subjected to a series of preliminary tests which have proved promising consists in using as the fluid for heating the hydrated salt a liquid that has complete solubility with water at high temperature and very little solubility at low temperature. When the hydrated salt reaches the

transition temperature, the water liberated by it dissolves in the heating fluid, forming a solution in which the salt is nearly insoluble. This solution is removed, and after giving up its sensitive heat in the short-term heat storage, is collected in a continuous separator, where it is separated into two phases--one composed mainly of water, and one composed mainly of the other liquid. This second phase returns into the solar collector, where it is warmed again and then into the column containing the salt to be dehydrated. The aqueous phase, on the other hand, is gradually collected in a tank provided for the purpose, where it remains ready to be used when the long-term stored heat is needed.

Other problems that must be studied in the small pilot installation concern the ways for integral recovery of the heat produced by salts that present several hydrated forms. This heat, as has been said, is developed at temperatures that decrease as hydration proceeds. This is not a disadvantage from the application point of view, both because heat in domestic uses is generally used at different temperatures (hot water for hygienic purposes, room-heating, etc) and because it is possible to envision countercurrent heat exchange that first uses the low-temperature heat developed in one zone of the column and subsequently, the high-temperature heat developed in another zone.

The experimental work will also include checking the behavior of various types of salt and of systems for heating and heat recovery, in relation to which it will be necessary to select the best-suited thermal fluids, case by case.

Finally, it is planned to investigate the possibility of applying concepts analogous to those illustrated above for achieving long-term storage of cold.

BIBLIOGRAPHY

1. Telkes, M. ASHRAEJ [American Society of Heating, Refrigerating and Air-Conditioning Engineers Journal], 9 (1974), pp 38-44.

2. Daniels, F. "Direct Use of the Sun's Energy," Yale University Press, 1964.

3. Hill, J.E. et al. SOLAR ENERGY, 19, 6 (1977), pp 721-732.

4. Morrison, D.J. et al. SOLAR ENERGY, 20, 1 (1978), pp 57-67.

5. Kauffmann, K.W. et al. Report NCEMP-20, University of Pennsylvania, Nat Cent Energ Man (1973).

6. Nemecek, J.J. et al. SOLAR ENERGY, 20, 3 (1978), pp 213-217.

7. Biswas, D.R. SOLAR ENERGY, 19, 1 (1977), pp 99-100.

8. Cavalleri, G. et al. SOLAR ENERGY, 19, 6 (1977), pp 677-683.

9. "Thermal Energy Storage," Report of NATO Science Comm Conf (1976), North Atlantic Treaty Organization, Brussels.

10. Chubb, T.A. SOLAR ENERGY, 17, 2 (1975), pp 129-136.

11. Wentwort, W.E. et al. SOLAR ENERGY, 18, 3 (1976), pp 205-214.

12. Prengle, H.W. et al. SOLAR ENERGY, 18, 6 (1976), pp 561-567.

13. Pryor, T.L. et al. SOLAR ENERGY, 20, 2 (1978), pp 151-155.

14. Pascal, P. "Nouveau Traite de Chimie Minerale" [New Treatise of Mineral Chemistry], Masson, 1966.

15. Othmer, Kirk "Encyclopedia of Chemical Technology," Vol 3, p 624.

16. CHEM ABSTR, 1939-917, 1939-5266.

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AERITALIA TO DESIGN, BUILD NEW COMMUTER AIRCRAFT

Naples IL MATTINO in Italian 14 Nov 79 p 9

[Article by Aldo Stefanile: "'Commuter' Aircraft To Be Built in Naples"]

[Text] Pomigliano d'Arco. If the necessary personnel and financial resources (150 engineers to be assigned for 4 years to the design and a sum of 50-60 million lire to be used in the development) are available, AERITALIA, the Italian aerospace company that has its headquarters in Naples, may begin the production of a new, completely Italian-designed and-built commercial aircraft within 5 years, commencing in late 1984. The aircraft would be competitive worldwide as a member of the family of commuter aircraft, that is, small aircraft designed for the rapid transport of groups of 30-40 passengers between large and small airports, low in cost and highly reliable. AERITALIA engineers have been working on this project--the model designation is AIT 230--under the supervision of Engineer Pelagalli, the technical director, and Engineer Conticelli, who is in charge of the technology, and the company has already requested support from the IMI [Italian Institute for Financing Personal and Real Property] in the form of funding (that is, financing) for the research work.

The company's officials say that AERITALIA technicians now have tremendous experience in the civil aviation sector and are perfectly capable of designing and building an aircraft. They have acquired considerable knowhow working for Douglas and Boeing, and are competent in the sector of military transport and combat aircraft. In the case of the AIT 230 design it is a question of building a small, simple aircraft that uses the most advanced technologies (such as composite materials with carbon fibers and bonding), but at the same time is not too sophisticated; an aircraft that is highly reliable, does not give trouble, can even take off from and land on airports with imperfect runways, and does not require outside assistance for starting the engines.

The "Commuter" that AERITALIA is designing meets these requirements. As explained by Engineer Conticelli, who has worked 6 years for NASA and another 6 years for Boeing it is an aircraft that is 16.35 m long, with a wing spread of 21.26 m, and a height of 6 meters above the ground. It has

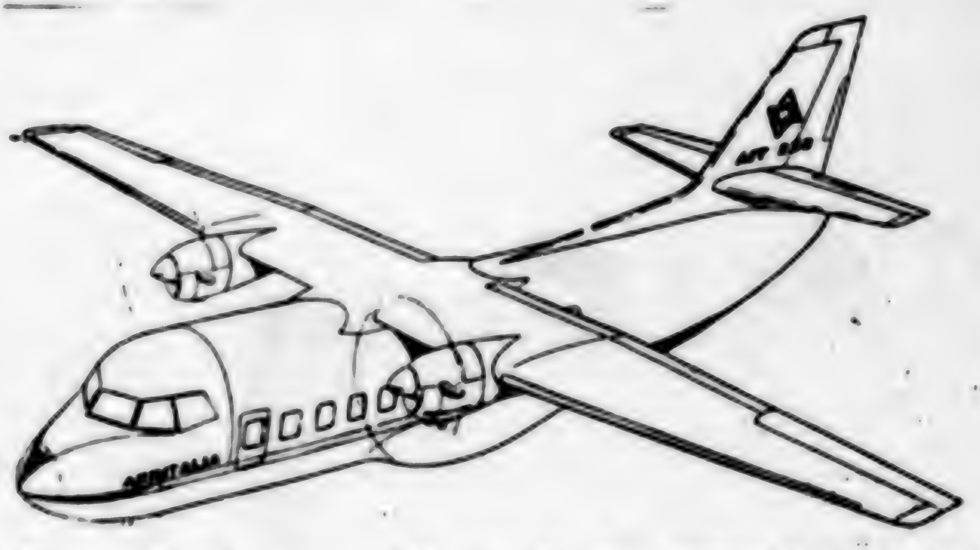
a carrying capacity of 30 passengers, but with minor modifications it can be converted into a 42-seater or small cargo aircraft.

"On the aircraft currently under study," says Engineer Conticelli, "we think we can install two Pratt & Whitney turboprop engines of 1,170 horsepower each (in this case the cruising speed at 7,000 meters would be 250 knots, and the range, 500 miles), or two engines of 1,500 horsepower each, also Pratt & Whitney, which will be ready in 1983. At today's prices, this type of aircraft could be sold for 2 million dollars each, which is a competitive price, even considering the fact that according to calculations the passenger-mile cost would be just 5 cents."

There is a large market for this type of aircraft, and in fact the Brazilians, Canadians, Germans, and Swedes are working on similar projects; the Canadians have already been given the go-ahead on building a model for 32-36 passengers (the DHC8), while the Germans and Swedes have obtained government financing to proceed with design work (on the DORNIER and the SAAB), and in America the General Commuter Co. has received a loan guarantee for 30 million dollars.

On the other hand AERITALIA feels that since many countries are interested in the production and the market would have an absorption capacity of some 1,500 craft in the 1980's, consideration should be given to a joint European venture or an agreement with an American firm on building the craft jointly. But these are merely hypotheses, for at the moment the Pomigliano firm is going ahead alone, and its studies are already well along.

The "Commuter" aircraft in the process of being designed appears feasible and seems to offer not only the possibility of providing work for labor, but also of utilizing the experience gained by engineers who have worked and are now working on aeronautical and aerospace projects within the framework of the company.



The "Commuter", the commercial aircraft that AERITALIA is designing

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SCIENTISTS EXPLORE USE OF BIOMASS FOR ENERGY

Professor Olle Lindstrom

Stockholm DAGENS NYHETER in Swedish 13 Nov 79 p 40

[Article by Birgitta Nyblom]

> [Text] Biofuel--energy forests, wood, trash wood from forestry operations, reeds, algae and peat--can free us from dependence on both nuclear power and oil. That is the opinion of Professor Olle Lindstrom who recently published a book on biological energy alternatives. By 1985 we could have big plantations for the production of energy forests, says Professor Gustaf Siren, who is in charge of some 20 test plots. At 2135 hours this evening there will be a debate on TV 1 concerning how we should use our forests in the future: for timber, pulp or fuel.

Biofuel Economical

"Sweden can be freed from dependence on oil at a reasonable cost." So says Professor Olle Lindstrom, whose book "Green Energy" has just been released.

"Biofuel is already economical. Just as we went over to oil after World War II because it was cheaper, now biofuel is cheaper. It could make Sweden independent of oil and nuclear power."

The sun is a large nuclear reactor. Enormous quantities of energy are received by the earth from the sun. Some of this energy is collected by the green plants that transform it into stored chemical energy.

Olle Lindstrom is professor of chemical technology at the Technical College. Here he transforms biomass into gas, motor fuel, oil or something else we need. Biomass consists of such things as young hardwood trees, plants,

wood, straw, trash, manure, peat, paper. The biomass that can be used as fuel is called biofuel.

He is especially well-known for his resignation from the Energy Commission which relied on him as a biofuel expert. But when the commission changed his statements to downgrade biofuel he quit.

"People will be making a terrible mistake if they fail to use the natural resources and natural process the earth offers us," says Olle Lindstrom.

"This is the first time that advocates of biofuel have been taken seriously," he says. "The power industry should make unbiased studies of various ways of producing energy. But instead of doing that they are onesidedly pointing out the uncertain aspects of biofuel.

Economical

"Already now there are economic reasons for investing in biofuel and starting to cultivate energy forests. Swedish hardwood trees could replace oil in a relatively short space of time."

Today research plantings of energy forests exist in some 20 different parts of the country under the leadership of Professor Gustaf Siren.

"The Swedish plants being considered for biofuel already exist in the Swedish landscape," Olle Lindstrom says. "Cultivated energy forests will lie somewhere between multi-faceted agriculture and single-faceted forestry.

Olle Lindstrom feels Sweden has good conditions for cultivating energy forests on a large scale:

"Rapid growth occurs in Sweden during the summer. We need fuel for heating purposes in the winter.

"We depend almost entirely on other countries for our fuel which is a strong reason for domestic production.

"In peat we have a total reserve of biofuel with almost the same properties as firewood. Marshy fields are well-suited for the cultivation of yellow birch.

"We have a forestry industry capable of cutting, transporting and processing the raw material.

"We have a varied modern agriculture containing the talent and resources needed for intensive cultivation of fuel crops.

"In proportion to the population we have a large land surface in Sweden. There is plenty of land for energy forests without disturbing other interests."

Promising

The Energy Production Research Board (NE) is working to find suitable plants for Swedish cultivation. Olle Lindstrom says he has found several promising groups of plants with the same genes, so-called clones, in his research activities. Requirements for the plants are high: they must root easily, have a good tendency to produce shoots, be resistant to damage, be able to stand the climate, produce dense wood, be capable of being dried, grow quickly and require only limited amounts of water and fertilizer.

Olle Lindstrom divides plant fuels into seven groups: willow and poplar plantations, old-fashioned firewood from hardwood forests, trash wood from thinning and cutting, peat, special biomasses such as reeds, straw, algae, sugar beets, etc., household trash and pulpwood (emergency fuel).

Thousands of Jobs

But can production of fuel on a large scale be started? How much capital is needed, how much labor is required, how much time would be needed and how much energy would we get out of this effort?

Kurt B. Heden, leader of the forest research program for biosystems with the Energy Production Research Board, replies:

"With a capital investment of 25 billion kronor and 25,000 work years we can produce within 25 years enough energy from Swedish energy forests to equal 25 million tons of oil."

At present Sweden imports around 27 million tons of oil a year.

"Cultivation of energy forests can guarantee energy supplies for the indefinite future," says Olle Lindstrom. "At the same time it can give new life to rural areas with declining populations.

Energy Fields

Cultivated land in Sweden declined by close to 1 million hectares between 1951 and 1974. At least a third of the abandoned fields can be used for energy forests, in his opinion.

"We have estimated that 2.7 million hectares of forest land are suitable for poplar cultivation in Gotaland and Svealand and another 2 million hectares in Norrland."

In its example of Solar Sweden, the study of the future entitled "Sun or Uranium" calculates that in the year 2015 46 percent of energy would come from energy forests and that forest plantations would occupy 6-7 percent of Sweden's land area.

Olle Lindstrom believes that developments are working for biofuel:

"Our ordinary politicians, the mighty trade unions and big industry will soon throw off their blinders and realize what biofuel can do for the economy and for employment in Sweden.

"In other words a transition to biofuel must begin now. Each new increase in oil prices will enhance the importance of doing so.

"A good beginning would be to free those in power and the common people from the common misconceptions concerning the indispensability of nuclear power and the inadequacy of biofuel."

Energy for All

Olle Lindstrom believes that we in Sweden have reached a limit. There must be a balance in world energy use so that developing countries can catch up with us. If they do we can supply the doubled population of the world with energy from biofuel. And everyone can benefit from this energy since no land can get exclusive rights to biofuel.

Gustaf Siren

Stockholm DAGENS NYHETER Swedish 13 Nov 79 p 40

[Text] "The main question is how to replace oil," says Professor Gustaf Siren. Electricity production is a secondary issue. He heads the state project, Energy Forest Cultivation, where they are developing intensive cultivation of so-called energy forests. He states that the important thing is to produce alternative energy raw materials that can be stored.

"These energy sources would be used for home heating as well as for fuel for nonrail transport of people and goods. A large portion of industrial needs for raw materials and energy should also be covered."

In his estimation Sweden has good possibilities for producing energy to substitute for oil. Trash wood, thinnings and cleared wood could provide a new supplement of 3 terawatt hours or 1 percent of our oil imports. That is not enough in the long run. Much more organic material is needed to replace a large enough quantity of oil. It is here that biomass in general comes into question, primarily energy forests. In addition to this there is a reserve in peat bogs suitable for mining.

Gustaf Siren feels that the energy crisis is partially self-inflicted. There has been a lack of farsightedness and resistance from various interest groups to constructive proposals, decreasing the opportunities to come to grips with the acute situation, he said. Now it is necessary to simultaneously develop several possible alternatives to oil.

Photosynthesis

"Crude oil comes from a mixture of products stored for long periods of time in plant growth with the help of what is called photosynthesis. Organic materials like wood and peat can relatively simply be turned into liquid fuel. Thanks to new knowledge it has been possible to develop a profitable production of wood fuel that is not harmful to the environment."

The Energy Forest Cultivation Project has achieved high cultivation results due to a strict selection of plant types. This strict selection must be continued by future planters, says Gustaf Siren. A core of authorized energy forest operators should also be created so that energy forests can make a real contribution to energy production starting in 1990.

"But if research results exceed expectations there could be enormous energy forest plantations as early as 1985. In practice these will probably be mixed energy forests with several varieties and many different clones.

"Even now," he told us, "it is possible to produce 25 tons of dry logs from 1 hectare of land per year. This is an environmentally correct production similar to the natural cycle with regard to adding fertilizer and carbon circulation. All we need is a small amount of suitable land in order to replace a third of our oil consumption with energy from wood fuel."

Research Plantations

With the exception of some preliminary studies in the 1960's the first energy forest seedlings were planted out in 1974 in Bogesundslandet's research plantation between Stockholm and Vaxholm. The Siren group made many mistakes.

"We gained 3 years of experience through negative developments. This gave us a unique opportunity to analyze the prerequisites for an ecological energy production."

It is important to keep in mind that the energy forests are there for the benefit of suburban areas and cities in need of home heating and motor fuel. The twenty-odd test plots are located on a line from Haparanda to central Dalarna. The trees are taken primarily from the Salix genus, goat willow, osier, basket willow, and others. Alders, birch and poplar

are found to a lesser extent. Alders are of special interest since they have the ability to bind the nitrogen in the air. This means they do not depend on nitrogen fertilizers.

"Nitrogen application can be a problem on poor soils incapable of binding large quantities of nitrogen," says Gustaf Siren. "To prevent leaching into the ground water fertilizer applications must occur in doses corresponding to the crop's ability to assimilate the increase in nourishment. It is this cultivation technology that we are trying to develop."

Gustaf Siren could set a clear target date for energy forests, 1985. But there is a plan in the eventuality that Sweden becomes isolated, one known to all forest owners.

"In the event of a catastrophe," he says, "we must produce biomass without abusing the resources of forestry, since we need our wood industry, timber, pulp and paper. The wood industry is there and it functions well."

Before him he has a number of sketches of biological cycles. The largest is a cycle including society. This must be incorporated into the natural cycle.

"This means that as much as possible our waste products must be returned to the natural cycle. The project will present a 3-year plan that will include the use of trash in energy forests," Gustaf Siren told us.

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